Northrop T-38

Airworthiness Certification

AIR-230 Airworthiness Branch
Federal Aviation Administration
Washington, D.C.

March 1, 2013

Front Cover Photograph: NASA.
Back Cover Photograph: USAF.

Introduction — T-38 Airworthiness Certification

This document provides information to assist in the airworthiness certification and safe civil operation of a T-38 aircraft.

Attachment 1 provides a general overview of this document. Attachment 2 contains background information on the T-38 aircraft. Attachment 3 lists historic airworthiness issues with the T-38 for consideration in the certification, operation, and maintenance of these aircraft. The list is not exhaustive, but includes our current understanding of risks that should be assessed during in the certification, operation, and maintenance of these aircraft. Concerns regarding particular issues may be mitigated in various ways. Some may be mitigated via the aircraft maintenance manual(s) or the aircraft inspection program. Others may be mitigated via operating procedures i.e., SOPs) and limitations, aircraft flight manual changes, or logbook entries

Not all issues in attachment 3 may apply to a particular aircraft given variations in aircraft configuration, condition, operating environment, or other factors. Similarly, circumstances with an aircraft may raise other issues not addressed by attachment 2 that require mitigation. Attachment 4 includes additional resources and references. Attachment 5 provides some relevant T-38 accident and incident data.

Attachment 1 – Overview of this Document

Purpose

This document is to provide all those involved in the certification, operation, and maintenance of the T-38 aircraft with safety information and guidance to help assess and mitigate safety hazards for the aircraft. The existing certification procedures in FAA Order 8130.2, Airworthiness Certification of Aircraft and Related Products, do not account for many of the known safety concerns and risk factors associated with many high performance former military aircraft. These safety concerns and risk factors associated with many high performance former military aircraft include-

- Lack of consideration of inherent and known design failures;
- Several single-point failures;
- Lack of consideration for operational experience, including accident data and trends;
- Operations outside the scope of the civil airworthiness certificate;
- Insufficient flight test requirements;
- Unsafe and untested modifications;
- Operations over populated areas (the safety of the non-participating public has not been properly addressed in many cases);
- Operations from unsuitable airports (i.e., short runways, Part 139 (commercial) airports);
- High-risk passenger carrying activities taking place;
- Ejection seat safety and operations not adequately addressed;
- Weak maintenance practices to address low reliability of aircraft systems and engines;
- Insufficient inspection schedules and procedures;
- Limited pilot qualifications, proficiency, and currency;
- Weapon-capable aircraft not being properly demilitarized, resulting in unsafe conditions;
- Accidents and serious incidents not being reported; and
- Inadequate accident investigation data.

Research of T-38 Safety Data

The aircraft, relevant processes, and safety data are thoroughly researched and assessed. This includes—

- Aviation Safety (AVS) Safety Management System (SMS) policy and guidance;
- Historical military accident/incident data and operational history;
- Civil accident data;
- Safety risk factors;
- Interested parties and stakeholders (participating public, non-participating public, associations, service providers, air show performers, flying museums, government service providers, airport owners and operators, many FAA lines of business, and other U.S. Government entities);
- Manufacturing and maintenance implications; and

- Design features of the aircraft.

This Document

The job aid is a compilation of known safety issues and risk factors identified from the above research that are relevant to civil operations. Attachment 3 of the job aid (Issues Table) is organized into four major sections:

- General airworthiness issues (grey section),
- Maintenance (yellow section),
- Operations (green section), and
- Standard operating procedures and best practices (blue section).

The job aid also provides background information on the aircraft and an extensive listing of resources and references.

How to Use the Document

This document was originally drafted as job aids intended to assist FAA field office personnel and operators in the airworthiness certification of these aircraft. As such, some of the phrasing implies guidance to FAA certification personnel. The job aids were intended to be used during the airworthiness certification process to help identify any issues that may hinder the safe certification, maintenance, or operation of the aircraft. The person performing the certification and the applicant would to discuss the items in the job aid, inspect documents/records/aircraft, and mitigate any issues. This information would be used to draft appropriate operating limitations, update the aircraft inspection program, and assist in the formulation of adequate operating procedures. There are also references to requesting information from, or providing information to the person applying for an airworthiness certificate. We are releasing this document as drafted, with no further updates and revisions, for the sole purpose of communicating safety information to those involved in the certification, operation, and maintenance of these aircraft. The identified safety issues and recommended mitigation strategies are clear and can be considered as part of the certification, operation, and maintenance of the air aircraft.

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Attachment 2—Background Information on the T-38 Aircraft

The Northrop T-38 is a 1960s high-performance jet trainer. The U.S. Air Force (USAF) has approximately 500 T-38 aircraft in its inventory. The T-38 is used in USAF Air Education and Training Command (AETC) to prepare student pilots for future training in fighter and bomber aircraft. The T-38's maiden flight was on April 10, 1959. It was the world's first supersonic trainer. Most T-38s built were of the T-38A variant, but the USAF also had a small number of aircraft converted for weapons training. There are three series in the aircraft line, the T-38A, AT-38B, and T-38C. The T-38A is a basic supersonic trainer aircraft, and the AT-38B is the lead-in fighter trainer, fitted with a gun sight and able to carry a gun pod, rockets, or bombs (bomb dispenser) on a centerline pylon. The T-38C is the updated trainer version. The T-38A (N) is NASA's upgraded aircraft.

An USAF T-38A in flight. The T-38A has been the center piece of the USAF advanced training for over 50 years. Source USAF.

The T-38 is of conventional configuration, with a small, low, long-chord wing, a single vertical stabilizer, and tricycle undercarriage. The aircraft is equipped with two General Electric J85-GE-5 turbojet engines, each rated at 2,680 lb without afterburner and 3,850 lb with afterburner. There are three fuselage bladder tanks and a dorsal bladder tank. The aircraft is a low-wing monoplane with a fuselage of semi-monocoque design constructed mainly of aluminum with steel and titanium. The cantilever all-metal tail has a hydraulically powered rudder and single-piece all-moving tail plane.

A USAF T-38 instructor in a T-38C. Note that this aircraft retains it original Northrop ejection seat rather that the new martin-Baker Mk. 16. Source: USAF.

Three Portuguese Air Force (PAF) T-38As on the ramp at BA5 Monte Real in 1984. Today, the T-38 continues to be a significant asset to many NATO countries as an advanced trainer. Source: FAA.

The aluminum alloy multi-spar wings are fitted with heavy metal plate-machined skins. The tandem cockpits are air-conditioned and pressurized. The cockpits have separate manually operated canopies, both jettisonable and rearward hinged. The cockpits, separated by a windshield, are equipped with rocket-powered ejection seats. The instructor's seat in the rear cockpit is raised to give a clear forward view.

The T-38s currently operated by the USAF have undergone continuous upgrades and improvements since the early 1980s. The USAF conducts the Pacer Classic program, which includes continuing upgrades to the airframe, powerplant, and cockpit instrumentation. An initial Pacer Classic upgrade included replacement of the wings, which began in 1981 and continued until 1986. The new wing was constructed of thicker skin in response to a series of in-flight breakups in 1978. In 2003, 562 T-38s were still operational with the USAF and are currently undergoing structural and avionics programs (T-38C) to extend their service lives to 2020. Improvements include the addition of a head-up display (HUD), Global Positioning System (GPS), inertial navigation system (INS), and traffic collision and avoidance system (TCAS), as well as a propulsion modification by the T-38 Propulsion Modification Program to improve low-altitude engine thrust. Many USAF variants (T-38A and AT-38B) are being converted to the T-38C standard. Another T-38 operator, the Turkish Air Force, started an upgrade program to keep its T-38s in service, as the T-38M, beyond 2020.

The T-38 was produced from 1961 through 1972. A total of 1,187 were produced with more than 500 still operational with the USAF today (700 were operational worldwide in 2008). USAF T-38 trainers are primarily used by the AETC for joint specialized undergraduate pilot training, but the aircraft are also used by the Air Combat Command for its companion training program and by the USAF Materiel Command to test experimental equipment. Pilots from North Atlantic Treaty Organization (NATO) countries are also trained on the T-38 at the Sheppard Air Force Base in Texas, through the Euro-NATO joint jet pilot training program. The USAF Thunderbirds acrobatic team used the T-38 from 1974 until 1982.

Other government operators of the T-38 include NASA, the U.S. Navy, the German Air Force, the Republic of China Air Force, Portugal (no longer), and the Turkish Air Force. As of 2012, the T-38 has been in service for over 50 years with its original operator (the USAF). NASA operates a fleet of 32 T-38 aircraft and uses the aircraft as a jet trainer for its astronauts, as well as a chase plane. Its fleet is housed primarily at Ellington Field in Houston, Texas. NASA's internal projections show the number of operational jet trainers falling to 16 by 2015. The agency spends between $25 million and $30 million annually to fly and maintain the T-38s.

The U.S. Navy also uses T-38s assigned to the United States Naval Test Pilot School (USNTPS) at Naval Air Station Patuxent River in Maryland. The USNTPS provides instruction to experienced pilots, flight officers, and engineers in the processes and techniques of aircraft and systems testing and evaluation. The school investigates and develops new flight test techniques, publishes manuals for standardization of flight test techniques and project reporting by the aviation test community, and conducts special projects.

Above, a USN T-38 assigned to the States Naval Test Pilot School (USNTPS). Source: NAVAIR. Below, USAF T-38 assigned to Edwards AFB. Source: USAF.

Northrop Grumman Corporation has produced a replacement wing for the T-38 that will help extend the service life of the aircraft, introduced in 1961, until at least 2020. T-38 wings are single units from tip to tip, constructed of aluminum alloys with control surfaces reinforced with internal honeycomb. Design improvements were developed from usage and retrofitted into many operational T-38s.

Top, maintenance being conducted on one of the USAF's T-38s. Source; USAF. Above, NASA's T-38 maintenance facility. Source: NASA.

There are possibly seven civilian T-38s operating in the United States. These include aircraft owned by the Boeing Corporation and Thornton Aircraft Company, as well as two privately owned aircraft. In the United States, T-38s are used for exhibition purposes (air shows) and research and development, and as chase aircraft, trainers, and platforms for military support missions, which include air combat maneuvering, radar calibration, and low-altitude cruise missile simulations. Used T-38s could potentially be imported from some foreign countries as replacement trainers come online in the next few years. In addition, T-38s removed from the Air Force Materiel Command's 309th Aerospace Maintenance and Regeneration Group at Davis-Monthan Air Force Base in Arizona for use in museums can possibly find their way to private collectors who then attempt to restore them to flying condition.

NASA T-38 in flight. Beginning in 1962, NASA has relied on the T-38 for astronaut training and transportation. Source: NASA.

USAF T-38C accident in 2011. Source: USAF.

The T-38 has a relatively good safety record in operations with the USAF. Its lifetime Class A mishap rate is 1.47 per 100,000 hours. The rate has been reduced over the years. For example, in 1966, it was at 3.6 per 100,000 hours, down from 7.5 in 1962.

Since 1960, when the T-38 first appeared in USAF Safety Center statistics, the T-38 has been involved in 203 Class A mishaps, resulting in 195 destroyed aircraft and 143 fatalities. Notably, operator-caused mishaps have outnumbered logistics-related mishaps approximately two to one in those 203 Class A mishaps. Class A mishaps are not the only data sets. Much can be learned from incidents as well. For example, in 1966, the number of incidents that accompanied the Class A mishap at the time (3.6 per 100,000 hours) reached 440. Of these, 45 were operator-related, 62 were maintenance-related, and 240 were materiel issues, while another 83 were classified as miscellaneous. Although current rates are most likely lower, the fact remains that the aircraft is not “trouble-free” in all aspects of its operation, and thus caution is required.

With that aid, today, the T-38 retains serious deficiencies, including flight control problems and design and material defects. As the USAF notes, “while the recent T-38 safety record has been impressive, there’s no room for complacency when operating a T-38.” Although the USAF has essentially accepted the T-38 flight control system design, it does not mean all civil operations are cleared. This is because the design allowed for multiple single-point failures in each of its three axes, and these have continued to impact safety since 1959. The aircraft's accident history, including recent fatal accidents, continues to highlight the T-38's susceptibility to catastrophic single-point failures in the flight control system.

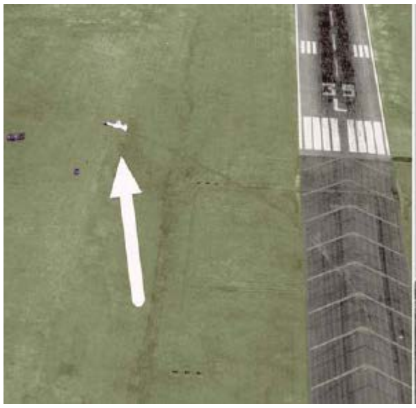
Structural issues, namely wing failures, have also surfaced in the T-38, despite the USAF's inspection procedures. Honeycomb structure failures in many of the critical components, are also an issue. This emphasizes the importance of adhering to the wing and other life limitations. Another issue with the aircraft is the J85 engine. The T-38 also has a recurring Class C mishap trend, mainly concerning engine problems. Of the reported Class C mishaps, most involved engine flameouts and engine shutdowns for reasons including false fire lights, loss of oil pressure, and failed gearboxes. T-38 pilots know the J85 has always been touchy when operated near the edge of the envelope, and as the engine ages, it will probably become more failure-prone. J85 flameouts have historically been related to operator technique, material factors, and component age. Other engine problems, such as stuck exhaust nozzles that overheated engines, have led to mishaps, including 47 Class C mishaps in 2007. The USAF's propulsion modernization (J85-5 to J85-5R), which include a new compressor and intake design, is intended to significantly reduce the J85's susceptibility to flameouts, while increasing performance.

The T-38 accident record also points to certain dangerous aspects of the aircraft's high performance. The most prominent is loss of control in the landing patterns, notably stalls turning final. Other failure modes and causes include runway excursions and landing gear failures. The aircraft's safety records can be attributed to the extensive level of USAF oversight provided as part of its flight training program. This high level of oversight, in terms of maintenance, operations, and program support, is the reason the inherent risks of the aircraft have been mitigated operationally. The structured AETC training programs, which constitute the main T-38 operational environments, have also contributed to the T-38's strong safety record. This is consistent with other segments of aviation where the instructional environment is inherently safer than the operational environment. In a manner similar to the USAF, NASA's T-38 program, which started in 1964, has also been first rate since the aircraft's introduction in 1960s.

However, once removed from these USAF or NASA environments, this high-performance aircraft, with a history of single-point failures, should not be assumed to actually maintain the same safety record it has enjoyed in USAF service. Safe civil operations require not only caution, but at many levels, a more conservative approach than the USAF has used. It also requires involvement in aircraft improvements in the areas of maintenance, inspections, and operational procedures. This is especially true because the civil T-38s in operation are either hybrid or rebuilt aircraft. Civil T-38s have not been operated by the USAF or NASA until recently, and have not benefited from the immense support systems in place.

Additionally, the T-38 is not a "simple" trainer that can be underestimated. It is a supersonic high-performance aircraft designed to emulate front-line fighters. Its approach speed above 160 knots, advanced aerodynamics, afterburning engines, and ejection seats are only a few of the aircraft's critical attributes with no equivalent in civilian aircraft, and these require professional oversight. Any one of these attributes, if left unchecked and unmitigated, could result in catastrophe.

The safe operation of T-38s as civil aircraft requires not only an understanding of the USAF operational environment, but also the safeguards that have been in place and added over 50 years of operational experience. While every aspect of civil operations does not equate to those of military operations, many do, and as such, must be considered. This is the guiding principle supporting the issues discussed in this document. The photographs in the following pages illustrate some of the accidents that have involved T-38s while in service with the USAF.




USAF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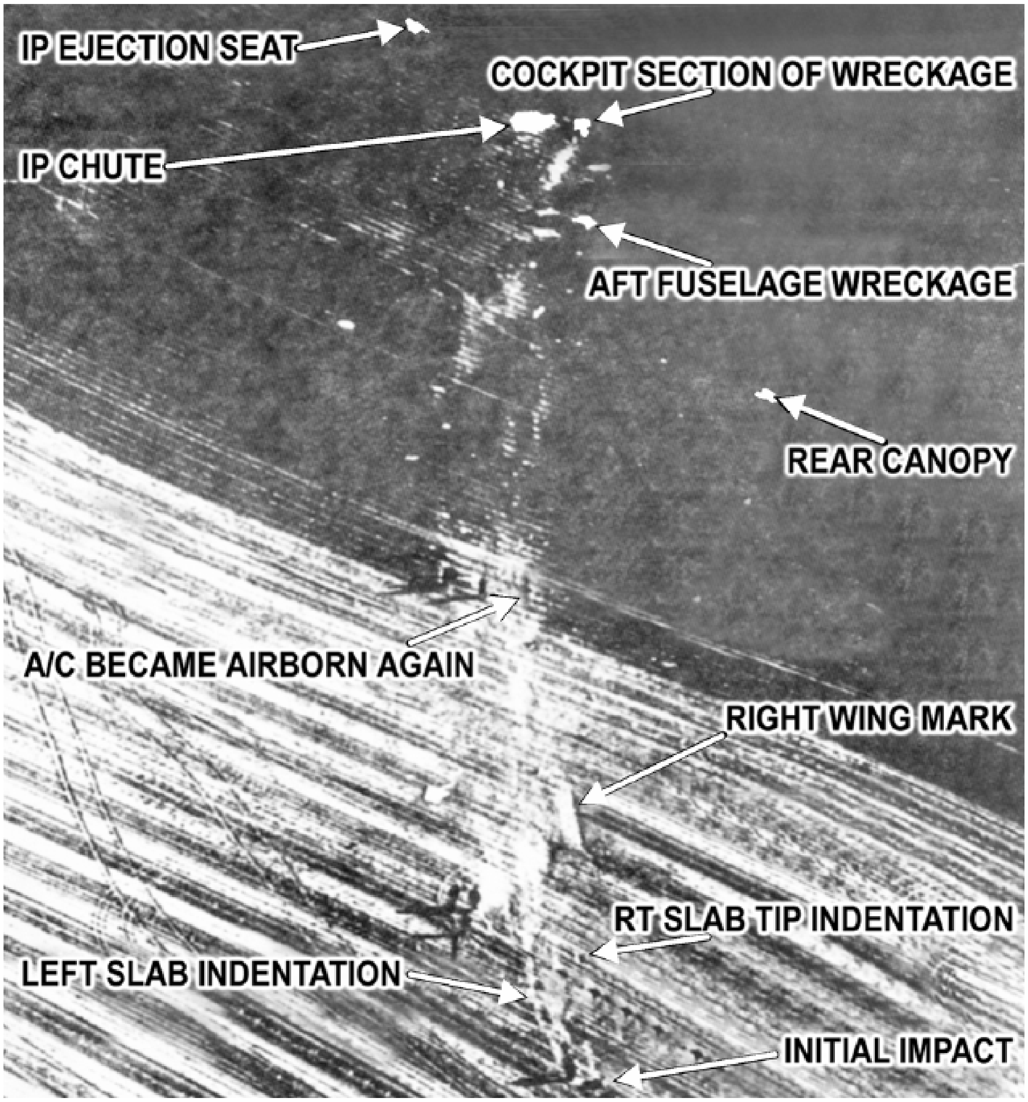
IP EJECTION SEAT
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REAR CANOPY
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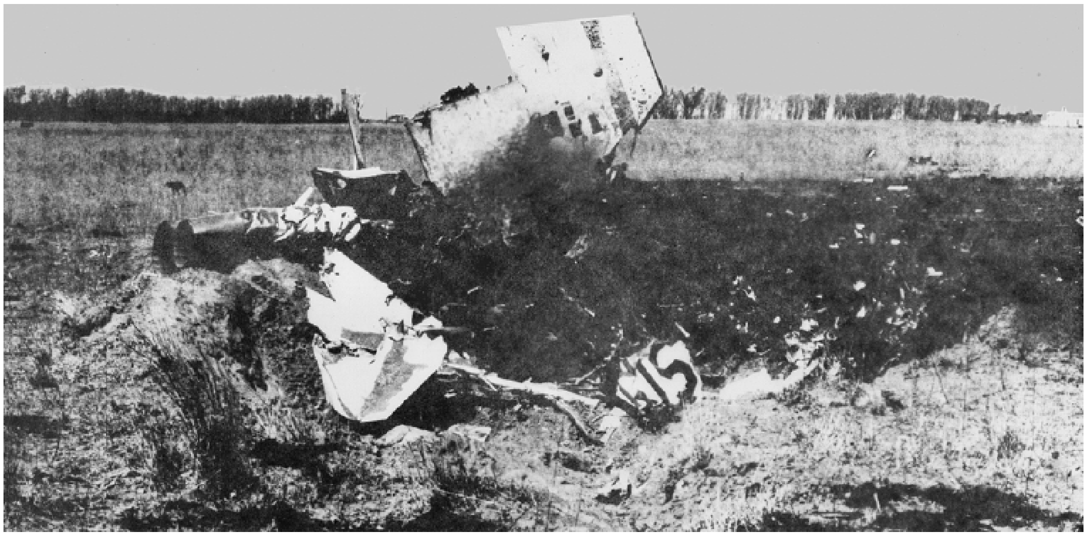
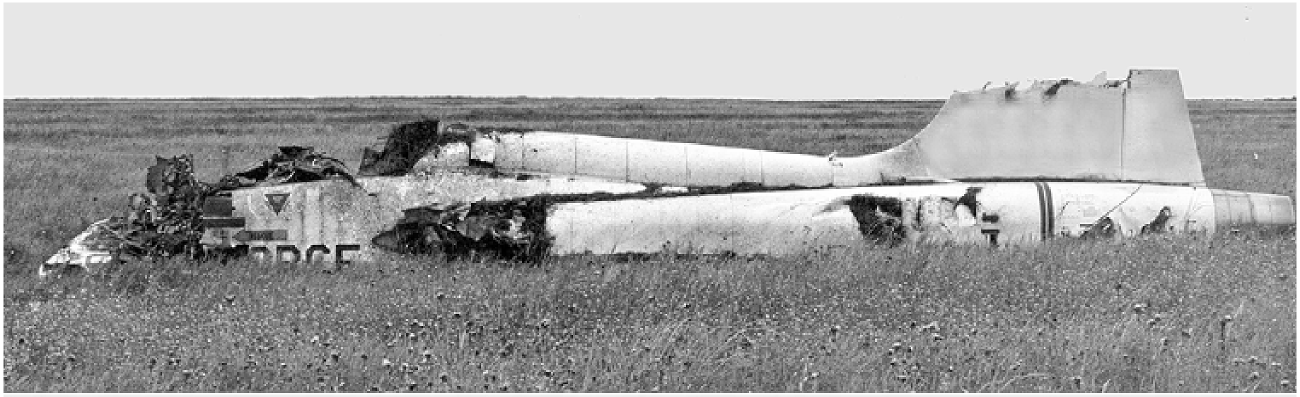
RT SLAB TIP INDENTATION
LEFT SLAB INDENTATION
INITIAL IMPACT


17


U.S. AIR FORCE






NO STEP
WALKWAY
NO STEP

T-38 Safety Data 1960-2011 (USAF Safety Center)

	Class A		Class B		Destroyed		Fatal			
Year	#	Rate	#	Rate	A/C	Rate	Pilot	All	Hours	Cum Hours
CY 60	0	0.00	0	0.00	0	0.00	0	0	974	974
CY 61	0	0.00	0	0.00	0	0.00	0	0	5,386	6,360
CY 62	3	7.15	1	2.38	3	7.15	0	1	41,945	48,305
CY 63	5	4.63	3	2.78	4	3.70	1	3	108,106	156,411
CY 64	6	2.87	3	1.43	6	2.87	1	2	209,285	365,696
CY 65	10	3.83	2	0.77	10	3.83	4	7	260,961	626,657
CY 66	13	3.63	2	0.56	10	2.79	3	5	358,001	984,658
CY 67	13	2.91	1	0.22	13	2.91	3	8	447,443	1,432,101
CY 68	10	1.98	1	0.20	9	1.78	5	10	504,977	1,937,078
CY 69	9	1.55	5	0.86	7	1.21	3	5	579,768	2,516,846
CY 70	17	2.81	1	0.17	17	2.81	7	12	605,430	3,122,276
CY 71	7	1.22	2	0.35	5	0.87	4	7	571,569	3,693,845
CY 72	9	1.68	1	0.19	10	1.87	2	5	535,538	4,229,383
CY 73	7	1.49	1	0.21	5	1.07	2	3	468,761	4,698,144
CY 74	9	2.24	0	0.00	9	2.24	6	10	402,336	5,100,480
CY 75	1	0.26	1	0.26	1	0.26	0	0	378,955	5,479,435
CY 76	8	2.52	2	0.63	8	2.52	4	9	317,300	5,796,735
CY 77	8	2.37	17	5.04	8	2.37	5	6	337,071	6,133,806
CY 78	7	2.25	23	7.40	7	2.25	1	4	310,702	6,444,508
CY 79	5	1.51	3	0.91	4	1.21	0	0	330,325	6,774,833
CY 80	4	1.19	4	1.19	4	1.19	2	4	335,813	7,110,646
CY 81	6	1.77	1	0.29	6	1.77	3	3	338,986	7,449,632
CY 82	3	0.83	0	0.00	6	1.66	5	5	362,514	7,812,146
CY 83	5	1.36	2	0.54	5	1.36	1	3	367,891	8,180,037
CY 84	3	0.80	3	0.80	4	1.07	3	5	373,825	8,553,862
CY 85	2	0.55	3	0.83	2	0.55	1	2	362,845	8,916,707
CY 86	4	1.14	1	0.29	4	1.14	2	3	349,457	9,266,164
TY 87	2	0.75	1	0.37	3	1.12	3	6	267,009	9,533,173
FY 88	2	0.57	2	0.57	2	0.57	1	1	351,132	9,884,305
FY 89	2	0.54	1	0.27	2	0.54	2	2	370,026	10,254,331
FY 90	2	0.55	2	0.55	2	0.55	0	0	361,878	10,616,209
FY 91	1	0.30	0	0.00	1	0.30	0	2	337,134	10,953,343
FY 92	1	0.38	0	0.00	0	0.00	1	1	265,369	11,218,712
FY 93	3	1.33	0	0.00	3	1.33	0	0	225,105	11,443,817
FY 94	0	0.00	0	0.00	0	0.00	0	0	194,161	11,637,978
FY 95	1	0.63	0	0.00	1	0.63	0	0	158,422	11,796,400
FY 96	1	0.75	0	0.00	1	0.75	0	0	133,959	11,930,359
FY 97	0	0.00	0	0.00	0	0.00	0	0	135,011	12,065,370
FY 98	0	0.00	1	0.71	0	0.00	0	2	141,448	12,206,818
FY 99	0	0.00	0	0.00	0	0.00	0	0	141,575	12,348,393
FY 00	0	0.00	2	1.39	0	0.00	0	0	144,311	12,492,704
FY 01	2	1.37	0	0.00	3	2.05	0	1	146,151	12,638,855
FY 02	0	0.00	0	0.00	0	0.00	0	0	145,913	12,784,768
FY 03	2	1.39	2	1.39	2	1.39	1	1	144,036	12,928,804
FY 04	1	0.72	2	1.43	1	0.72	0	0	139,378	13,068,182
FY 05	0	0.00	2	1.60	0	0.00	0	0	125,341	13,193,523
FY 06	2	1.57	1	0.79	1	0.79	0	0	127,261	13,320,784
FY 07	2	1.71	2	1.71	2	1.71	0	0	117,107	13,437,891
FY 08	2	1.90	2	1.90	2	1.90	4	4	105,279	13,543,170
FY 09	2	2.17	4	4.35	2	2.17	1	1	92,051	13,635,221
FY 10	0	0.00	0	0.00	0	0.00	0	0	99,408	13,734,629
FY 11	1	0.99	2	1.98	0	0.00	0	0	101,228	13,835,857
5 Yr Average	1.4	1.36	2.0	1.94	1.2	1.16	1.0	1.0	103,014.6	
10 Yr Average	1.2	1.00	1.7	1.42	1.0	0.84	0.6	0.6	119,700.2	
Lifetime	**203**	**1.47**	**109**	**0.79**	**195**	**1.41**	**81**	**143**	**13,835,857**	

Specifications (T-38A)

<u>General Characteristics</u>

- Crew: 2 (student and instructor)
- Length: 46 ft 4.5 in
- Wingspan: 25 ft 3 in
- Height: 12 ft 10.5 in
- Wing area: 170 ft²
- Empty weight: 7,200 lb
- Loaded weight: 11,820 lb
- Maximum takeoff weight: 12,093 lb

  Powerplant: 2 × General Electric J85-5A (J85-5R after propulsion modification) afterburning turbojets

  - Dry thrust: 2,050 lb each
  - Thrust with afterburner: 3,850 lb each

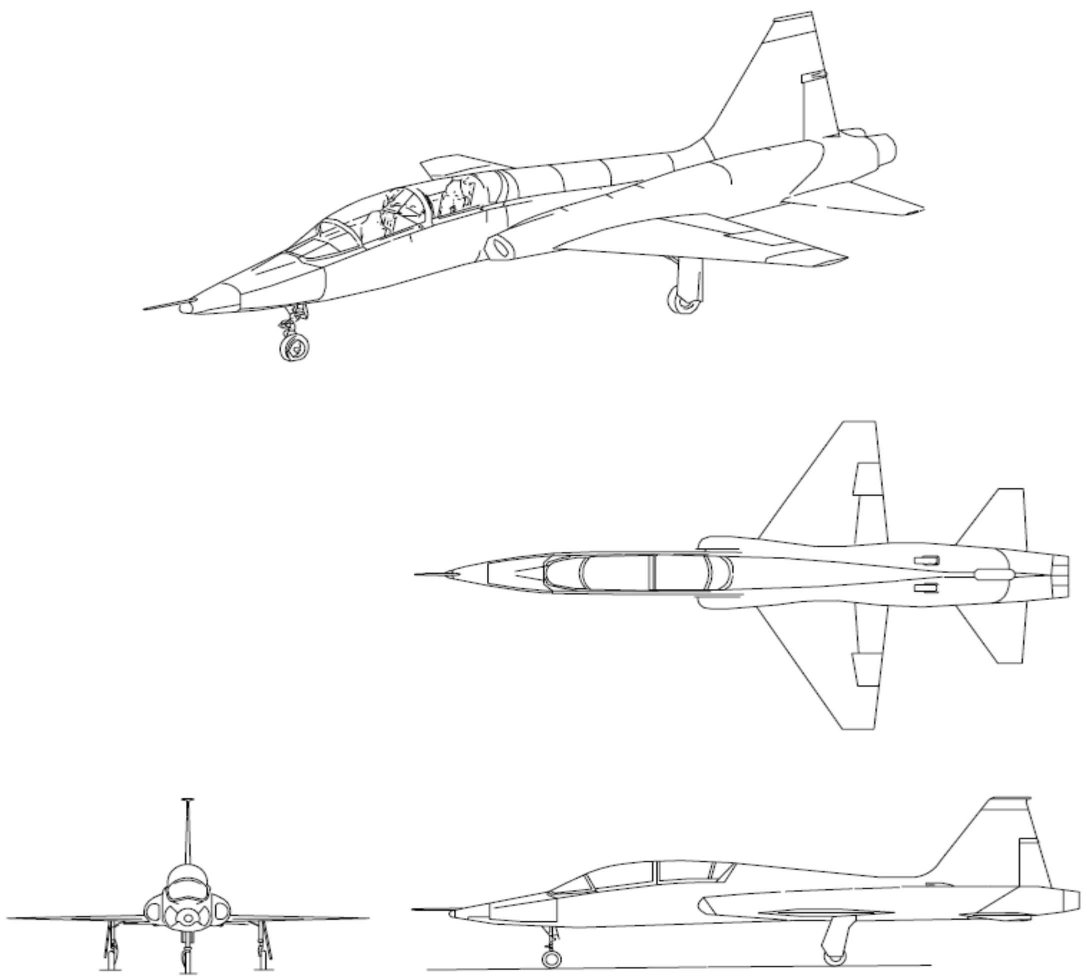
<u>Performance</u>

- Maximum speed: Mach 1.3
- Range: 1,140 mi
- Service ceiling: 50,000 ft
- Rate of climb: 33,600 ft/min
- Wing loading: 70 lb/ft²
- Thrust/weight: 0.65

Source: USAF.

T-38 Versions and Variants

- N-156T: Northrop company designation.
- YT-38: Prototypes, two built with YJ85-GE-1 engines (later designated YT-38A) and four pre-production aircraft with YJ85-GE-5 engines (later designated T-38A).
- T-38A: Two-seat advanced training aircraft, production model, 1,139 built.
- T-38A (N): Two-seat astronaut training version for NASA.
- AT-38A: A small number of T-38As were converted into weapons training aircraft.
- DT-38A: A number of U.S. Navy T-38As were converted into drone directors.
- NT-38A: A small number of T-38As were converted into research and test aircraft.
- QT-38A: Unmanned target drone aircraft.
- AT-38B: Two-seat weapons training aircraft.
- T-38C: A T-38A with structural and avionics upgrades.
- T-38M: Modernized Turkish Air Force T-38As with full glass cockpit and avionics, upgraded by Turkish Aerospace Industries under the project codename "ARI."
- T-38N: Upgraded NASA T-38As.



4-view T-38 diagram. Source: USAF.

Source: USAF.

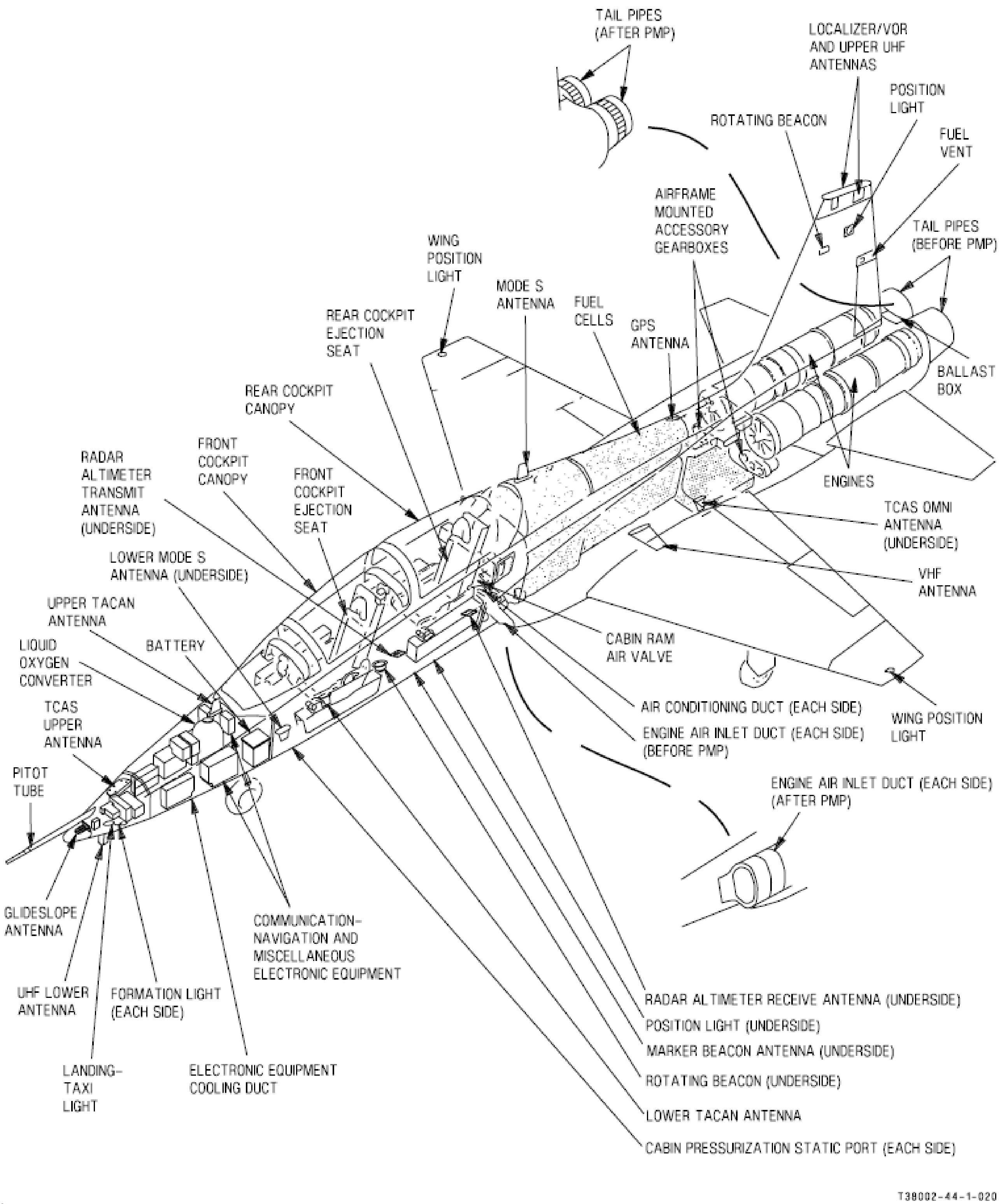


Figure 1-1. General Arrangement

Source: USAF.

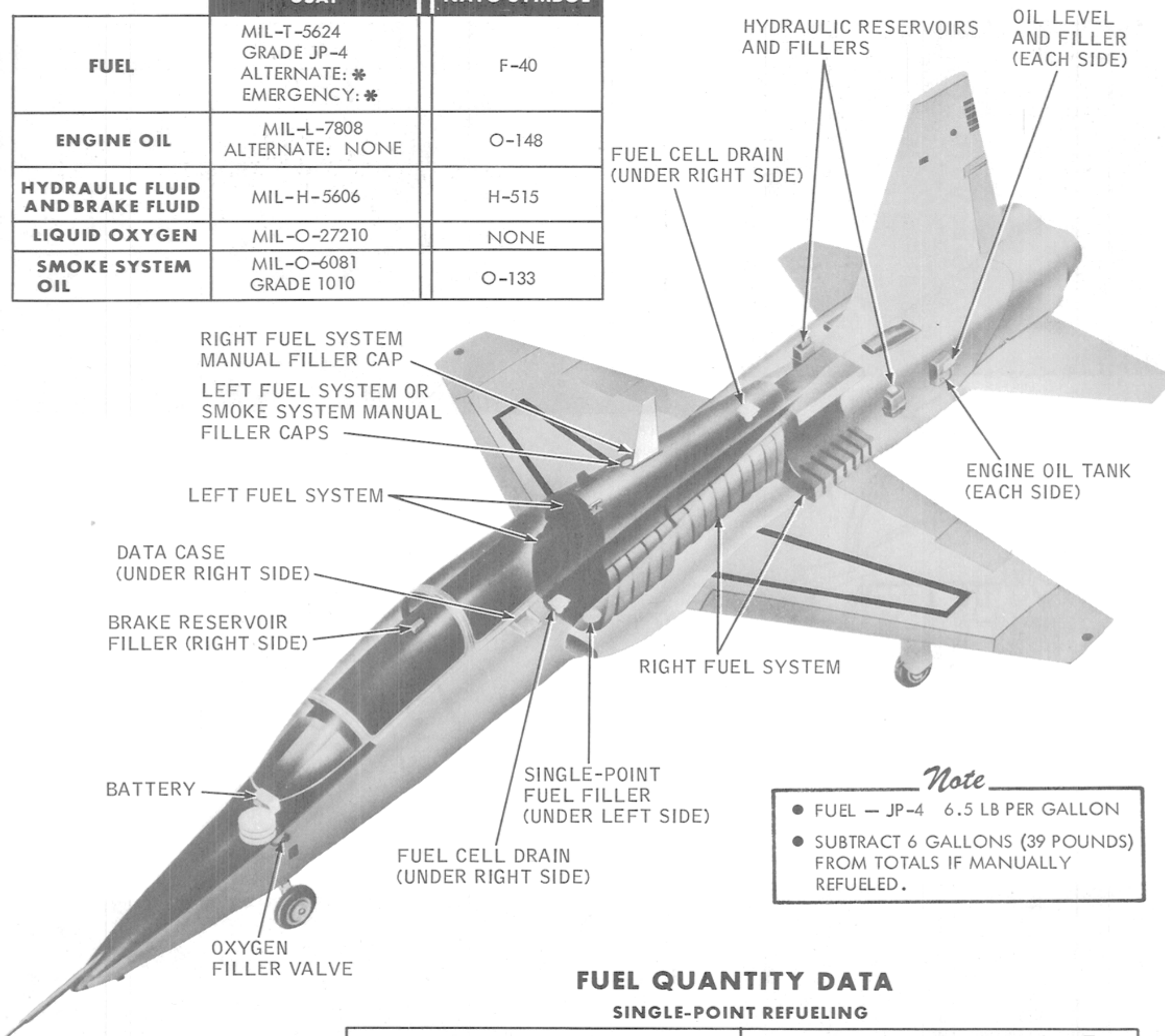
SERVICING DIAGRAM

*** Note**

REFER TO STRANGE FIELD PROCEDURES IN T.O. 1T-38A-1 SECTION II for ELECTRICAL UNITS, AIR-STARTING UNITS, ALTERNATE AND EMERGENCY FUEL OPERATING INFORMATION.

FLUID SPECIFICATION

	USAF	NATO SYMBOL
FUEL	MIL-T-5624 GRADE JP-4 ALTERNATE: * EMERGENCY: *	F-40
ENGINE OIL	MIL-L-7808 ALTERNATE: NONE	O-148
HYDRAULIC FLUID AND BRAKE FLUID	MIL-H-5606	H-515
LIQUID OXYGEN	MIL-O-27210	NONE
SMOKE SYSTEM OIL	MIL-O-6081 GRADE 1010	O-133



Note

- FUEL — JP-4 6.5 LB PER GALLON
- SUBTRACT 6 GALLONS (39 POUNDS) FROM TOTALS IF MANUALLY REFUELED.

FUEL QUANTITY DATA

SINGLE-POINT REFUELING

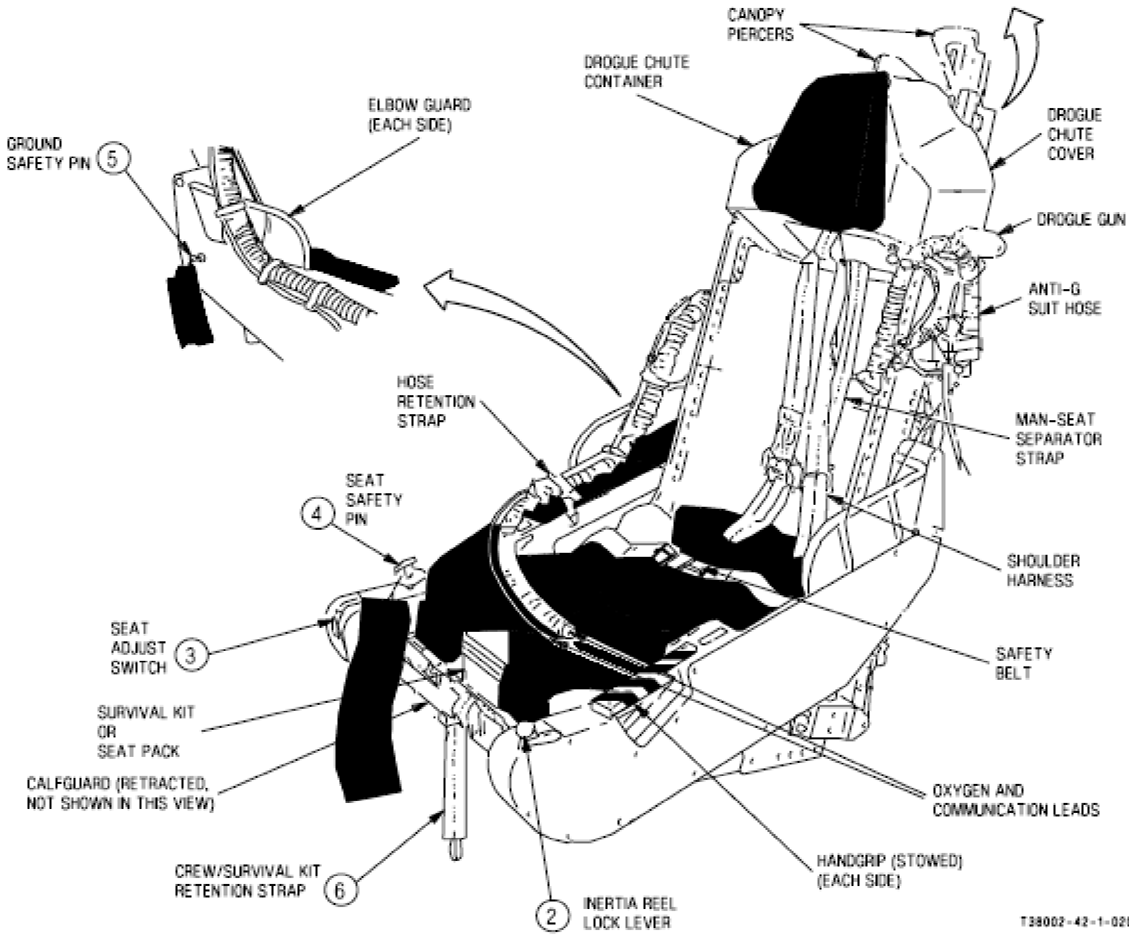
	FERRY CONFIGURATION				SHOW CONFIGURATION ❶			
	FULLY SERVICED		USABLE		FULLY SERVICED		USABLE	
	GALLONS	POUNDS	GALLONS	POUNDS	GALLONS	POUNDS	GALLONS	POUNDS
LEFT SYSTEM	293	1905	286	1859	244	1586	237	1540
RIGHT SYSTEM	305	1982	297	1931	305	1982	297	1931
TOTAL	598	3887	583	3790	549	3568	534	3471

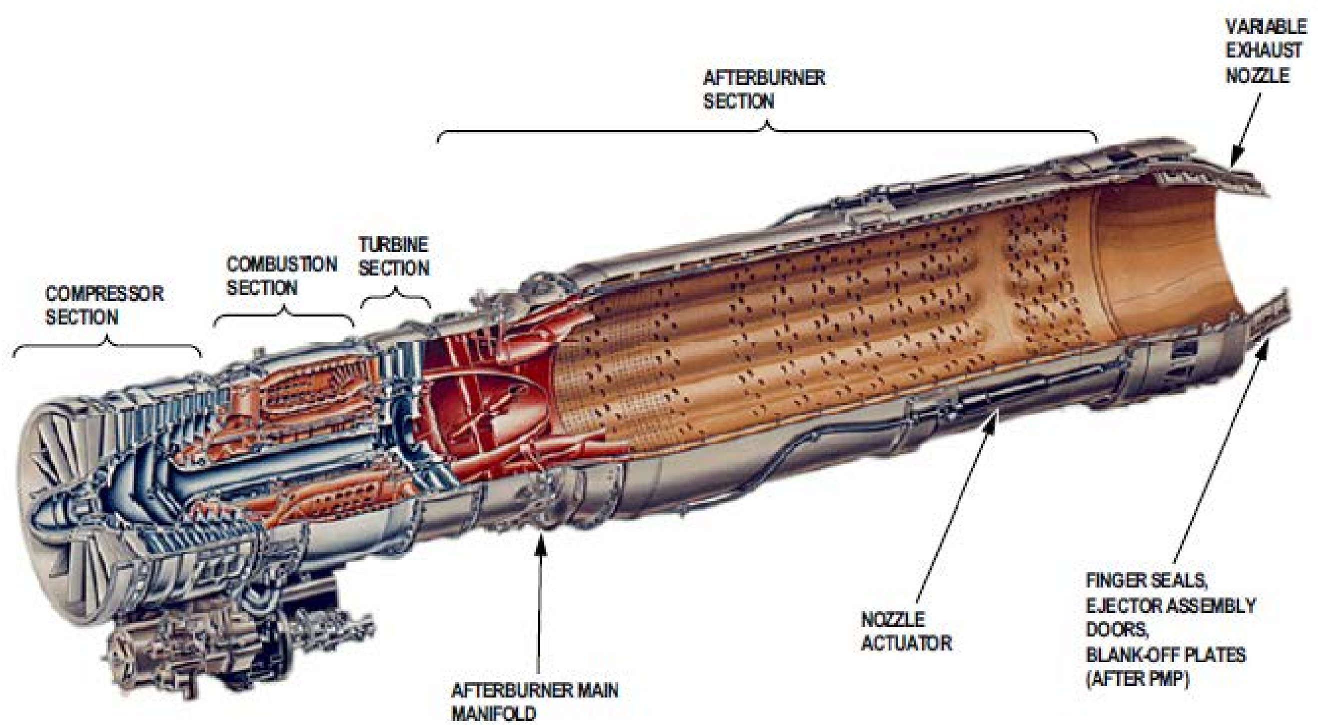
❶ SMOKE SYSTEM CONTAINS 49 GALLONS OF OIL

DATA BASIS: **ACTUAL**
DATE: 1 JUNE 1974

T-38A (TB) 1-15A

Source: USAF.


CANOPY PIERCERS
DROGUE CHUTE CONTAINER
ELBOW GUARD (EACH SIDE)
GROUND SAFETY PIN 5
DROGUE CHUTE COVER
DROGUE GUN
ANTI-G SUIT HOSE
HOSE RETENTION STRAP
MAN-SEAT SEPARATOR STRAP
SEAT SAFETY PIN 4
SHOULDER HARNESS
SEAT ADJUST SWITCH 3
SAFETY BELT
SURVIVAL KIT OR SEAT PACK
CALFGUARD (RETRACTED, NOT SHOWN IN THIS VIEW)
OXYGEN AND COMMUNICATION LEADS
HANDGRIP (STOWED) (EACH SIDE)
CREW/SURVIVAL KIT RETENTION STRAP 6
2 INERTIA REEL LOCK LEVER
T38002-42-1-020


VARIABLE EXHAUST NOZZLE
AFTERBURNER SECTION
TURBINE SECTION
COMBUSTION SECTION
COMPRESSOR SECTION
FINGER SEALS, EJECTOR ASSEMBLY DOORS, BLANK-OFF PLATES (AFTER PMP)
NOZZLE ACTUATOR
AFTERBURNER MAIN MANIFOLD

Source: USAF.

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#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
T-38 Preliminary and General Airworthiness Inspection Issues			
1.	Aviation Safety (AVS) Safety Management System (SMS) Guidance	Use the AVS SMS guidance as part of the airworthiness certification process, as it supplements the existing Code of Federal Regulations (CFR). FAA Order VS8000.367 (May 14, 2008) and FAA Order VS8000.369 (September 30, 2008) are the basis for, but not limited to (1) identifying hazards and making or modifying safety risk controls, which are promulgated in the form of regulations, standards, orders, directives, and policies, and (2) issuing certificates. AVS SMS is used to assess, verify, and control risks, and safety risk management is integrated into applicable processes. Appropriate risk controls or other risk management responses are developed and employed operationally. Safety risk management provides for initial and continuing identification of hazards and the analysis and assessment of risk. The FAA provides risk controls through activities such as the promulgation of regulations, standards, orders, directives, advisory circulars (AC), and policies. The safety risk management process (1) describes the system of interest, (2) identifies the hazards, (3) analyzes the risk, (4) assesses the risk, and (5) controls the risk.	
2.	Aircraft Familiarization	Become familiar with the aircraft before initiating the certification process. One of the first steps in any aircraft certification is to be familiar with the aircraft in question, in this case the T-38. Such knowledge, including technical details, is essential in establishing a baseline as the certification process moves forward.	
3.	Preliminary Assessment	Conduct a preliminary assessment of the aircraft to determine condition and general airworthiness. A Manufacturing Inspection District Office (MIDO) inspector may seek Flight Standards District Offices (FSDO) support as part of this process. Coordination between the offices may be essential in ensuring adequate technical expertise.	
4.	Condition for Safe Operation	This is an initial determination by an FAA inspector or authorized representative of the Administrator that the overall condition of an aircraft is conducive to safe operations. This refers to the condition of the aircraft relative to wear and deterioration. The FAA inspector will make an initial determination as to the overall condition of the aircraft. The aircraft items evaluated depend on information such as aircraft make, model, age, type, completeness of maintenance records of the aircraft, and the overall condition of the aircraft.	
5.	Main Safety Issues	This document addresses the following general safety concerns regarding the T-38: • Lack of consideration of inherent and known design failures; • Lack of consideration for operational experience, including accident data and trends; • Operations outside the scope of the airworthiness certificate being sought; • Insufficient flight test requirements; • Unsafe and untested modifications; • Operations over populated areas (the safety of the non-participating public has not been pro addressed in many cases); • Operations from unsuitable airports; • High-risk passenger carrying activities taking place; • Ejection seat safety and operation not adequately addressed; • Weak maintenance practices to address low reliability of aircraft systems and engines; • Ignoring required inspection schedules and procedures; • Limited pilot qualifications, proficiency, and currency; • Weapon-capable aircraft not being demilitarized, resulting in unsafe conditions; • Extensive brokering; • Extensive use of unqualified Designated Airworthiness Representatives (DAR); • Accidents and serious incidents not being reported; and • Inadequate accident investigation data.	
6.	Denial	The FAA will provide a letter to the applicant stating the reason(s) for denial and, if feasible, identify which steps may be accomplished to meet the certification requirements if the aircraft does not meet them and the special airworthiness certificate is denied. Should this occur, a copy of the denial letter will be attached to FAA Form 8130-6 and forwarded to AFS-750, and made a part of the aircraft's record.	

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7.	Potential Reversion Back to Phase I	Notify the applicant that certain modifications to the aircraft will invalidate Phase II. These include: (a) structural modifications, (b) aerodynamic modifications, including externally mounted equipment except as permitted in the limitations issued, and (c) change of engine make, model, or power rating (thrust or horsepower). The owner/operator may return the aircraft to Phase I to flight test specific items as required. However, major modifications such as those listed above may require new operating limitations. Phase I may have to be expanded as well. In August 2012, the National Transportation Safety Board (NTSB) issued safety recommendations concerning a fatal accident of an experimental high-performance aircraft that had undergone extensive modifications. The NTSB noted "the accident airplane had undergone many structural and flight control modifications that were undocumented and for which no flight testing or analysis had been performed to assess their effects on the airplane's structural strength, performance, or flight characteristics. The investigation determined that some of these modifications had undesirable effects. For example, the use of a single, controllable elevator trim tab (installed on the left elevator) increased the aerodynamic load on the left trim tab (compared to a stock airplane, which has a controllable tab on each elevator). Also, filler material on the elevator trim tabs (both the controllable left tab and the fixed right tab) increased the potential for flutter because it increased the weight of the tabs and moved their center of gravity aft, and modifications to the elevator counterweights and inertia weight made the airplane more sensitive in pitch control. It is likely that, had engineering evaluations and diligent flight testing for the modifications been performed, many of the airplane's undesirable structural and control characteristics could have been identified and corrected." As part of the probable cause, the NTSB stated that "contributing to the accident were the undocumented and untested major modifications to the airplane and the pilot's operation of the airplane in the unique air racing environment without adequate flight testing." As a result of this investigation, the NTSB issued safety recommendations, including requiring "aircraft owners to provide an engineering evaluation that includes flight demonstrations and analysis within the anticipated flight envelope for aircraft with any major modification, such as to the structure or flight controls." Refer to *Modifications* and *Phase I Flight Testing* below.	
8.	Identify T-38 Version and Sub-Variants	Identify the series of the T-38 aircraft in question, that is, Series A, A (N) (NASA), B, C, GT-38A, NT-38A, or GAT-38B. There are differences among and between the different series of T-38s, many in terms of wings, engines, internal modifications (longerons), and instrumentation. These differences and their impact on the airworthiness of the aircraft are discussed throughout this document.	
9.	Major Structural Components	Ask the applicant to identify and document the origin, condition, and traceability of major structural components. This is an issue with the T-38 because the aircraft was not surplused by the U.S. Air Force (USAF) and may have been restored from an accident aircraft or using major subcomponents. For example, T-38A N638TC (63-8171) was "rebuilt" by the Thornton Corporation from a wreck following an accident at Grandview NAS in July 1973. Another civilian T-38A (ex-USAF 65-10462) was also disposed as a wreck but later rebuilt by the Thornton Corporation following a December 1970 accident. A T-38 (N38MX) is actually the result of the front end of a T-38 mated with the aft end of an F-5A to form a "T-38A/F-5A."	
10.	Aircraft Records	Request and review the applicable military and civil aircraft records, including aircraft and engine logbooks.	
11.	Data Plate, Block Number and Serial Number	Verify the military identification plate is installed. Record all information contained on the identification plate. Block number and serial number also need to be identified.	
12.	Technical Order (TO) 00-5-1, AF Technical Order System	Become familiar with TO 00-5-1, AF Technical Order System, dated May 1, 2011. This document provides guidance in the USAF TO system, which guides much of the documentation associated with the T-38 aircraft.	
13.	Aircraft Ownership	Establish and understand the aircraft's ownership status, which sets the stage for many of the responsibilities associated with operating the aircraft safely. There are many cases where former military aircraft are leased from other entities, and this can cloud the process. For example, if the aircraft is leased, the terms of the lease may be relevant as part of the certification because the lease terms may restrict what can be done to the aircraft and its operation for safety reasons.	
14.	FAA Records Review	Review the existing FAA airworthiness and registration files (EDRS) and search the Program Tracking and Reporting Subsystem (PTRS) for safety issue(s) and incidents.	

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15.	FAA Form 8100-1	Use FAA Form 8100-1 to document the airworthiness inspection. Using this form facilitates the listing of relevant items to be considered, those items' nomenclature, any reference (that is, NATO manual; FAA Order 8130.2, Airworthiness Certification of Aircraft and Related Products; regulations) revision, satisfactory or unsatisfactory notes, and comments. Items to be listed include but are not limited to— 1. FAA Form 8130-6; 2. 14 CFR § 21.193; 3. FAA Form 8050-1; 4. 14 CFR § 45.11(a); 5. FAA Order 8130.2, paragraphs 4002a(7) and (10), 4002b(5), 4002b(6), 4002b(8), 4111c, and 4112a(2); 6. 14 CFR § 91.205; 7. § 91.417(a)(2)(i), airframe records and total time, overhaul; and 8. § 91.411/91.413, altimeter, transponder, altitude reporting, static system test.	
16.	FAA-G-8082-19	Recommend that *Inspection Authorization Information Guide*, FAA-G-8082-19, FAA, Flight Standards Service, 2010 be considered (as a tool) as part of the airworthiness certification process. This document includes valuable information that is relevant to an airworthiness inspection. This publication provides guidance for persons who conduct annual and progressive inspections and approve major repairs and/or major alterations of aircraft. This manual stresses the important role that certificated mechanics that hold an inspection authorization have in air safety.	

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17.	Airframe and Engine Data	Ask applicants to provide the following: Airframe: • Import country (if applicable), • N-Number, • Manufacture year and serial number, and • Airframe time and airframe cycles. Engine: • Type and variant, • Manufacture date and serial number, and • Overhaul data, location, provider, and engine time and cycles. Properly identifying the relevant and basic characteristics of the airframe and the engine are necessary to address the safety issues with the aircraft. The following excerpt from an NTSB report on a former military jet accident illustrates the seriousness of adequate records: "On May 15, 2005, a British Aircraft Corporation 167 Strike Master MK 83, N399WH, registered to DTK Aviation, Inc., collided with a fence during an aborted takeoff from Boca Raton Airport, Boca Raton, Florida. The airplane was substantially damaged and the commercial-rated pilot and passenger sustained minor injuries. The pilot initially stated he performed a preflight inspection of the aircraft which included a flight control continuity check. He had the passenger disable the gust lock for the flight controls. He performed a flight control continuity check before taxiing onto the runway for takeoff; no discrepancies were reported. The takeoff roll commenced and at the calculated rotation speed (70 knots), he '...began to apply pressure to stick and noticed an unusual amount of load on the controls. I made a quick trim adjustment to ensure that the forces on the stick were not the results of aerodynamic loads. When the trim changes yielded no change, I initiated an abort (at approximately Vr at 80 knots) by retarding the throttle, extending the speed brakes, and applying the wheel brakes.' He notified the tower of the situation, briefed the passenger, and raised the flaps. He also opened the canopy after realizing that he was unable to stop on the runway. The airplane traveled off the end of the runway, rolled through a fence and came to rest upright. The pilot also stated that the airplane is kept outside on the ramp at the Boca Raton Airport. Examination of the airplane by an FAA operations inspector before recovery revealed the control column would only move aft between 1/4 and 1/2 inch. No determination was made as to the position of the control lock in the cockpit. Examination of the airplane following recovery by an FAA airworthiness inspector revealed that the elevator was free to travel through the full range but was noted to be '...very stiff.' Additionally, the rudder was '...extremely hard to move in either direction." During movement of the elevator flight control surface, the rudder flight control surface was noted to move, and with movement of the rudder flight control surface, the elevator flight control surface was noted to move. A review of a United Kingdom Civil Aviation Authority (U.K. CAA) Mandatory Permit Directive (MPD) No. 2002-001 R1, issued on January 16, 2003, indicates "partial binding or complete seizure of the elevator/rudder concentric torque tube bearings causing an interconnect between elevator and rudder control systems. This interconnection has resulted in un-commanded rudder movement with the application of elevator control inputs and vice versa. Investigation has determined that bearing seizure was due to inadequate lubrication and water ingress in the elevator torque tube bearings. Aircraft subject to external storage are particularly prone to this occurrence. A review of the airplane maintenance records revealed the airplane was last inspection on June 29,2004, in accordance with, '...the scope and detail of the inspection program approved by the FSDO for BAC Strikemaster dated June 29, 2001, and found it to be in safe operating condition at this time.' The logbook entry does not indicate airplane total time; therefore, the time since the inspection was not determined. There was no record that U.K. CAA MPD No. 2002-001 R1 had been complied with."	
18.	Functionality Check	Ask the applicant to prepare the aircraft for flight, including all preflight tasks, startup, run-up, and taxi.	
19.	Accident and Incident Data System	Review the NTSB accident database and the FAA's Accident and Incident Data System for T-38 aircraft accidents and incidents. Refer to http://ntsb.gov and http://www.asias.faa.gov.	
20.	Accident and Incident History	Ask the applicant to provide any data concerning all accidents and/or incidents involving the aircraft. This includes any knowledge of any such events in military service. Attachment 5 of this document can be used as a reference. Note: This is important because several of the civil T-38s were restored following serious accidents while in military service.	

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21.	Adequate T-38 Manuals and Related Documentation	Ensure the existence of a complete set of the applicable USAF manuals, such as flight manuals, inspections and maintenance manuals, and engine manuals. There are over 150 such documents. An operator also needs to have the applicable technical orders (TO) to address known issues related to airworthiness, maintenance, and servicing. Some of the relevant T-38 manuals include— • TO 1T-38A-1 and AT-38B-1 Aircraft, Flight Manual USAF Series; • TO 1T-38A-1, Flight Manual (AF 59-1603 and Later Aircraft); • TO 1T-38C-1, Flight Manual—T-38C Aircraft (Boeing); • MCMAN 11-238, Volume 2, (A)T-38 Mission Employment Fundamentals; • USAF TO 1T-38A-1-1 Performance Supplement; • General Airplane Organizational Maintenance Technical Manual TO 1T-38A-2; • Aircraft Structural Repair Instructions Manual, TO 1T-38A-3; • Corrosion Control, USAF Series T-38A and T-38B Aircraft, TO 1T-38A-23; • Nondestructive Inspection, USAF Series T-39A and T-38B Aircraft, TO 1T-38A-36; • Ground Handling, Servicing and Airframe Maintenance Technical Manual, TO 1T-38AB-2-2; • Hydraulically Operated Systems and Utility Systems Technical, TO 1T-38A-2-3; • Flight Control Systems, TO 1T-38AB-2-4; • Power Plant, TO 1T-38AB-2-5; • Power Plant, 1T-38A-4-6; • Electrical Systems, TO 1T-38A-2-7; • Electrical Systems, 1T-38A-4-7; • Landing Gear Systems, 1T-38A-4-8; • Flight Controls Systems, 1T-38A-2-3; • Instruments, 1T-38A-4-9; • Inspection of the Aileron Acce., 1T-38A-4-9; • Pneudralics, 1T-38A-2-4; • Aircraft Illustrated Parts Breakdown Manual, TO 1T-38AB-4; • Aircraft Organizational Maintenance Manual - Wiring Diagrams and Data, TO 1T-38A-2-8; and • Basic Weigh Checklist and Loading, TO 1T-38A-5; • Specialized Storage and Maintenance Procedures - Rocket Catapult & Ballistic Catapult, TO 11P1-31-7; • Specialized Storage and Maintenance Procedures - Cartridge Actuated Thrusters, TO 11P6-1-7, and • Specialized Storage and Maintenance Procedures - Cartridges Actuated Initiators, TO 11P3-1-7. • Formal Flying Training Administration and Management T-38; • Air Force Instructions (AFI) 11-2T-38, T-38 Aircrew Training; • AFI 11-2T-38 T-38, Aircrew Evaluation Criteria; • AFI 11-2T-38, T-38 Aircrew Training; and • AFI 21-103, Equipment Inventory, Status, and Utilization Reporting System/T-38A Minimum Essential Subsystem List (MESL). For additional TOs, refer to http://www.newportaero.com/air_force_technical_order_search.php?s=100&q=1T-38A&stype=TO number.	

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22.	Related USAF Publications	The following are examples of some of the USAF publications relevant to T-38 operations: • Department of Defense Directive (DODD) 5230.24, Distribution Statements on Technical Documents; • AFI 10-206, Operational Reporting; • AFI 10-601, Capabilities Based Requirements Development; • AFI 11-215, USAF Flight Manuals Program; • Air Force Materiel Command Manual (AFMCMAN) 21-1, AFMC Technical Order Procedures; • AFI 21-101, Aerospace Equipment Maintenance Management; • AFI 21-103, Equipment Inventory, Status, and Utilization Reporting; • AFI 21-104, Selective Management of Selected Gas Turbine Engines; • AFI 21-118, Improving Air and Space Equipment Reliability and Maintainability; • AFI 21-302, Processing Interim Technical Orders and Rapid Action Changes; • Air Force Manual (AFMAN) 23-110, USAF Supply Manual; • AFI 24-303, Command/Air Force Vehicle Integrated Management System and Consolidated Analysis and Reporting; • AFI 40-201, Managing Radioactive Materiels in the USAF; • Air Force Policy Directive (AFPD) 63-11, Modification System; • AFPD 63-12, Assurance of Operational Safety, Suitability, & Effectiveness; • AFI 63-1101, Modification Management (to be superseded by AFI 63-131, Modification Program Management); • TO 00-5-3, AF Technical Order Life Cycle Management; • TO 00-5-18, USAF Technical Order Numbering System; • TO 00-20-1, Aerospace Equipment Maintenance, Inspection, Documentation, Policies and Procedures; • TO 00-20-2, Maintenance Data Documentation; • TO 00-25-4, Depot Maintenance of Aerospace Vehicles and Training Equipment; • TO 00-25-107, Maintenance Assistance; • TO 00-25-254-1, Comprehensive Engine Management System Engine Configuration, Status and TCTO Reporting Procedures; • TO 00-35D-54, USAF Materiel Deficiency Reporting and Investigating; • TO 00-105E-9, Aerospace Emergency Rescue and Mishap Response Information (Emergency Services); • Military Performance Specification MIL-PRF-38804, Time Compliance Technical Orders, Preparation of; and • TO 00-5-1 AF, Technical Order System.	
23.	Operational Supplements	Ensure the owner/operator has a complete set of the applicable USAF operational supplements to safely operate a T-38.	
24.	Availability of Documents Listed in the Applicable Aircraft List of Applicable Publication Manual	Review the aircraft inspection program (AIP) to verify compliance with the applicable version of Northrop T-38 aircraft list of applicable publication manuals or equivalent document. This document should contain the complete listing of all applicable USAF T-38 TOs.	
25.	Applicant/Operator Capabilities	Review the applicant/operator's capabilities, general condition of working/storage areas, availability of spare parts, and equipment.	
26.	Scope and Qualifications for Restoration, Repairs, and Maintenance	Familiarize yourself with the scope of the restoration, repairs, and maintenance conducted by or for the applicant.	
27.	Limiting Duration of Certificate	Refer to § 21.181 and FAA Order 8130.2, regarding the duration of certificates, which may be limited. An example would be to permit operations for a period of time to allow the implementation of a corrective action or changes in limitations. In addition, an ASI may limit the duration if there is evidence additional operational requirements may be needed at a later date.	

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28.	Compliance With § 91.319(a)(1)	Inform the operator that the aircraft are limited under this regulation. The aircraft cannot be operated for any purpose other than the purpose for which the certificate was issued. For example, in the case of an experimental exhibition certificate, the certificate can be used for air show demonstrations, proficiency flights, and flights to and from locations where the maintenance can be performed. Such a certificate is NOT IN EFFECT for flights related to providing military services (that is, air-to-air gunnery, target towing, electronic countermeasures (ECM) simulation, cruise missile simulation, and air refueling). Also refer to *Military/Public Aircraft Operations* below.	
29.	Multiple Certificates	Ensure the applicant submits information describing how the aircraft configuration is changed from one to the other in those cases involving multiple airworthiness certificates. This is important because, for example, some research and development (R&D) activities may involve equipment that must be removed to revert back to the exhibition configuration (refer to *R&D Airworthiness Certification* below). Moreover, the procedures should provide for any additional requirement(s), such as additional inspections, to address situations such as high-G maneuvering that could impact the aircraft and/or its operating limitations. Similarly, it should address removing R&D equipment that could be considered part of a weapon system (refer to *Demilitarization* below). All applications for an R&D certificate must adhere to FAA Order 8130.29, Issuance of a Special Airworthiness Certificate for Show Compliance and/or Research and Development Flight Testing.	
30.	Public Aircraft Operations, State Aircraft Operations, Military Support Missions, DOD contracts	The special airworthiness certificate and attached operating limitations for this aircraft are not in effect during public aircraft operations (PAO) as defined by Title 49 of the United States Code (49 U.S.C.) §§ 40102 and 40125. They are also not in effect during state aircraft operations (typically military support missions or military contracts), as defined by Article 3 of the International Civil Aviation Organization's (ICAO) Convention on International Civil Aviation. *Aircraft used in military services are deemed state aircraft.* Also refer to *Operations Overseas* below.	
31.	Re-Conforming to Civil Certificate	Following a public, state, or military aircraft operation, ensure the aircraft is returned, via an approved method, to the condition and configuration at the time of airworthiness certification before operating under the special airworthiness certificate issued following a public, state, or military aircraft operation. This action must be documented in a log or daily flight sheet. Ensure the applicant submits information describing how the aircraft configuration is changed from PAO, state aircraft, or other non-civil classification or activity back to a civil certificate. This is important because, for example, some military support activities may involve equipment or maneuvers that must be removed or mitigated to revert back to original Exhibition or R&D configuration. Moreover, the procedures should provide for any additional requirement(s), such as additional inspections, to address situations such as high-G maneuvering and sustained Gs that could have an impact on the aircraft and/or its operating limitations. Similarly, it should address removing equipment that could be considered part of a weapon system. Refer to *Demilitarization* below.	
32.	R&D Airworthiness Certification	R&D certification requires a specific project. Ensure the applicant provides detailed information such as— • Description of each R&D project providing enough detail to demonstrate it meets the regulatory requirements of § 21.191(a); • Length of each project; • Intended aircraft utilization, including the number of flights and/or flight hours for each project; • Aircraft configuration; • Area of operation for each project; • Coordination with foreign CAA, if applicable; and • Contact information for the person/customer that may be contacted to verify this activity. Note: All applications for an R&D certificate should include review of FAA Order 8130.29.	
33.	Temporary Extensions	This new certification process using an aircraft-specific job aid is being introduced as aircraft are being considered for certification. As a result, the process allows for the field offices to consider temporary extensions of existing airworthiness certificates, as appropriate. This will enable AIR-200 to complete drafting the aircraft-specific job aid and allow the field inspector(s) and the applicant additional time to complete a full review with the job aid. Field inspectors are cautioned when issuing a temporary extension to ensure any safety issues they believe need to be addressed and corrected are mitigated as part of this process. FAA Headquarters (AIR-200, AFS-800, and AFS-300) will assist with any questions concerning issues affecting the aircraft.	

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34.	Demilitarization	Verify the aircraft has been adequately demilitarized. This aircraft must remain demilitarized for all civil operations. Refer to *TCTO 1T-38A-889* below. The T-38, as the AT-38, has a secondary mission as gun platform trainer. In those cases, wiring, switches, and other subsystems need to be disabled as well. General safety issues with these systems include inadvertent discharge of flares, toxic chaff, and electrical overloads of the aircraft electric system, danger of inadvertent release, structural damage, complex flight limitations, and harmful emissions. Although not extensive, weapon systems in the AT-38 include— • SUU-21 bomb dispenser unit, SUU-20A rocket dispenser, • Bomb and rocket intervalometers, SUU-11 .30 Minigun pod, • Mk. 4 bomb rack, AF-B37K-1 bomb rack, • BDU-33 series practice bombs, 2.75-in rockets, • ALQ-167 and ALE-40 chaff and flare pod. For other systems, refer to *AT-38B USAF Test Equipment* below. Note: One hundred thirty-four T-38s were modified in the late 1970s as AT-38Bs (first to T-38B, and then to AT-38B), and these were capable of carrying weapon and related systems. TO 00-80G-1, Make Safe Procedures for Public Static Display, dated November 30, 2002, can be used as a reference as well.	
35.	AT-38B USAF Test Equipment	In testing, the USAF has expanded the use of the AT-38 in terms of weapon systems. The following is provided as background in case the applicant proposes any such changes or modifications to the aircraft. The fact that some of the equipment has been installed by the USAF in test aircraft does not mean civil use is acceptable. If there are such proposals, AIP and operating limitations issues may have to be addressed in addition to those already covered in this document. The following USAF description of the 586th Flight Test Squadron (586th FLTS) discusses these capabilities. The 586th FLTS "plans, analyzes, coordinates, and conducts flight tests of advanced weapons and avionics systems primarily on the White Sands Missile Range (WSMR). As part of this effort, the capabilities of the squadron's AT-38B's include: chaff, flares, Global Positioning System (GPS) navigation and precision data recording and telemetry, electronic counter-measures (ECM), towed target, threat and cruise missile simulation, Air Combat Maneuvering Instrumentation (ACMI) pods, and multiple format photographic coverage (including helmet-mounted video cameras. They are equipped with an internal Fighter Instrumentation and Navigation System (FINS) which relies on inertial navigation and global positioning inputs to develop a reference for time-space-position information. Each aircraft has a 200-ft AGL capability utilizing radar altimeters and moving map displays. For specialized tests, customer provided test equipment may be rack mounted and installed in place of the rear ejection seat or externally in a pod. Externally, the aircraft has a modified centerline pylon to enable carriage of many types of test and operational stores such as the ALQ-167 Electronic Counter Measures (ECM) pod, which is programmable with a wide variety of electronic jamming techniques as well as ALE-40 chaff and flare pod. External stores can be provided with AC and DC power. Another test capability under development is a Low Observable Instrumented Tow Target system that will support many different types of tests. Flight cleared pods are available for carriage of additional customer defined stores."	
36.	Safety Discretion	The field inspector may add any requirements necessary for safety. Under existing regulations and polices, FAA field inspectors have discretion to address any safety issue that may be encountered, whether or not it is included in the job aid. Of course, in all cases, there should be justification for adding requirements. In this respect, the job aid provides a certain level of standardization to achieve this, and in addition, AIR-200 is available to coordinate a review (with AFS-800 and AFS-300) of any proposed limitations an inspector may consider adding or changing. 49 U.S.C. § 44704 states that before issuing an airworthiness certificate, the FAA will find that the aircraft is in condition for safe operation. In issuing the airworthiness certificate, the FAA may include terms required in the interest of safety. This is supported by case law. 14 CFR § 21.193, Experimental Certificates: General requires information from an applicant, including, "upon inspection of the aircraft, any pertinent information found necessary by the Administrator to safeguard the general public." 14 CFR § 91.319 *Aircraft Having Experimental Certificates: Operating* provides "the Administrator may prescribe additional limitations that the Administrator considers necessary, including limitations on the persons that may be carried in the aircraft." Finally, FAA Order 8130.2, chapter 4, Special Airworthiness Certification, effective April 16, 2011, also states the FAA may impose any additional limitations deemed necessary in the interest of safety.	

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37.	2009 Crash of ZU-BEX	Recommend the accident report concerning the 2009 Lightning T5 ZU-BEX be reviewed in detail. This report, published by the South African CAA in August 2012, provides valuable insight into the consequences of operating complex and high-performance former military aircraft in an unsafe manner. The relevant issues identified in the report include (1) ignoring operational history and accident data, (2) inadequate maintenance practices, (3) granting extensions on inspections, (4) poor operational procedures, and (5) inadequate safety oversight. Many of the issues discussed and documented in the accident investigation report are directly relevant to safety topics discussed in this T-38 airworthiness review document. The South African CAA report can be found at http://www.caa.co.za/.	
38.	Importation	Review any related documents from U.S. Customs and Border Protection and the Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) for the aircraft. If the aircraft was not imported as an aircraft, or if the aircraft configuration is not as stated in Form ATF-6, it may not be eligible for an airworthiness certificate. There are many cases in which Federal authorities have questioned the origin of former military aircraft and its installed weapon system. Some have been seized. For example, two T-28s were seized at the Canadian border by U.S. Customs officials in 1989. Refer to Federal Firearms Regulations Reference Guide, ATF Publication 5300.4, Revised September 2005, for additional guidance.	
39.	Brokering	Verify the application for airworthiness does not constitute brokering. Section 21.191(d) was not intended to allow for the brokering or marketing of experimental aircraft. This includes individuals who manufacture, import, or assemble aircraft, and then apply for and receive experimental exhibition airworthiness certificates so they can sell the aircraft to buyers. Section 21.191(d) only provides for the exhibition of an aircraft's flight capabilities, performance, or unusual characteristics at air shows, and for motion picture, television, and similar productions. Certificating offices must verify all applications for exhibition airworthiness certificates are for the purposes specified under § 21.191(d) and are from the registered owners who will exhibit the aircraft for those purposes. Applicants must also provide the applicable information specified in § 21.193.	

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40.	Restrictions on Operations Overseas	Inform the applicant/operator that operations may be restricted and permission must be granted by a foreign CAA. The applicable CAA may impose any additional limitations it deems necessary, and may expand upon the restrictions imposed by the FAA on the aircraft. In line with existing protocols, the FAA will provide the foreign CAA any information, including safety information, for consideration in evaluating whether to permit the operation of the aircraft in their country, and if so, under what conditions and/or restrictions. It is also noted any operator offering to use a U.S. civil aircraft with an experimental certificate to conduct operations such as air-to-air combat simulations, ECM, target towing for aerial gunnery, and/or dropping simulated ordinances pursuant to a contract or other agreement with a foreign government or other foreign entity would not be doing so in accordance with any authority granted by the FAA as the State of Registry or State of the Operator. On the issue of operations overseas: • Under international law, the aircraft will either be operated as a civil aircraft or a state aircraft. The aircraft cannot have a combined status. If the aircraft are to be operated with civil status, then they must have FAA-issued airworthiness certificates. If the applicant/operator is seeking experimental certificates for R&D or Exhibition purposes for the aircraft, and if the FAA issues (or renews) those certificates for the aircraft, then the only permissible operation of the aircraft as civil aircraft in a foreign country, is for an R&D or Exhibition purpose. The applicant/operator cannot be allowed to accomplish other purposes during the same operation, such as performing the contract for a foreign air force. This position is necessary to avoid telling an operator that any R&D or Exhibition activity could serve as a cover for a whole host of improper activities using an aircraft with an experimental certificate for R&D or Exhibition purposes, rendering the R&D or Exhibition limitation on the certificate meaningless. • The R&D or Exhibition activity would be a pretext for the real purpose of the operation. Accordingly, in issuing experimental certificates for an R&D or Exhibition purpose, the FAA must make it clear that any other activities or purposes for the operation are outside the scope of permitted operations under the certificate. The FAA must also make clear that the operation as a civil aircraft requires the permission of the foreign civil aviation authority (CAA). In requesting that permission, the applicant/operator should advise the foreign aviation authority that the operation will be for an R&D or Exhibition purpose only and for no other purpose, including performing a contract for any foreign military organization. • The applicant/operator must understand that if the foreign CAA asks FAA about the operation, the FAA will state “that the only permissible purpose of the operation is R&D or Exhibition, and an operation for any other purpose, even when conducted in conjunction with an R&D or Exhibition purpose, is outside the scope of the operations allowed under the certificate. • If the applicant/operator operates the aircraft as state aircraft, then the national government of some country will have designated the aircraft as its state aircraft, and the host country, will have given the aircraft permission to operate through the issuance of a diplomatic clearance. That diplomatic clearance should include whatever terms and conditions that CAA deems necessary or appropriate for the operation. • The aircraft, when operated as state aircraft, does not need an FAA airworthiness certificate, and the pilots of those aircraft do not need to hold FAA-issued airman licenses. • If a country issues a diplomatic clearance for the operation of the aircraft, the aircraft would be deemed to be a state aircraft of the country requesting that clearance. Safety oversight would rest with the country that requested the diplomatic clearance.	

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41.	Federally Obligated Airport Access	Inform the operator T-38 operations may be restricted by airports because of safety considerations. As provided by 49 U.S.C. § 47107(a), a federally obligated airport may prohibit or limit any given type, kind, or class of aeronautical use of the airport if such action is necessary for the safe operation of the airport or necessary to serve the civil aviation needs of the public. Additionally, per FAA Order 5190.6, FAA Airport Compliance Manual, the airport should adopt and enforce adequate rules, regulations, or ordinances as necessary to ensure safety and efficiency of flight operations and to protect the public using the airport. In fact, the prime requirement for local regulations is to control the use of the airport in a manner that will eliminate hazards to aircraft and to people on the ground. In all cases concerning airport access or denial of access, and based on FAA Flight Standards Service safety determination, FAA Airports is the final arbiter regarding aviation safety and will make the determination (Director's Determination, Final Agency Decision) regarding the reasonableness of the actions that restrict, limit, or deny access to the airport (refer to FAA Docket 16-02/08, FAA v. City of Santa Monica, Final Agency Decision; FAA Order 2009-1, July 8, 2009; and FAA Docket 16-06-09, Platinum Aviation and Platinum Jet Center BMI v. Bloomington-Normal Airport Authority).	
42.	Environmental Impact (Noise)	Inform the operator that T-38 operations may be restricted by airport noise access restrictions and noise abatement procedures in accordance with 49 U.S.C. § 47107. As a reference, refer to FAA Order 5190.6. Note: The J85 engines are extremely noisy and this may have implications in terms of airport access and compliance with any FAA-approved noise levels restriction.	

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43.	Initial Contact Checklist	The following is a sample of the contents of an initial contact by an FAA field office to an applicant concerning a proposed certification. It addresses many of the major safety and risk issues with the T-38 and will assist in (1) preparing an airworthiness applicant, (2) making corrections and updating any previous application, and (3) documenting the level of airworthiness review. 1. Discuss item missing from the application. a. Program letter setting the purpose for which the aircraft will be used. i. Exhibition of aircraft flight capabilities, performance, unusual characteristics at air shows, motion picture, television and similar productions, and maintenance of exhibition flight proficiency, including flying to and from such air shows and productions. ii. Aircraft cannot be certified if the intention is to broker or sell the aircraft. iii. Aircraft photos. 2. Prepare aircraft and documentation for FAA inspection. a. Maintenance and modification records. b. Aircraft history and logbooks (airframe, engine, and components). c. Have the aircraft maintenance program ready for review and acceptance. d. Have operations and maintenance and supplements. e. Have crew qualifications ready for review (pilot, mechanics, A&P, IA). f. Be prepared to show spare parts records. g. Be prepared to accomplish preflight, ground checks, run-up, and taxi checks. h. Be prepared to demonstrate the aircraft has been demilitarized. i. Have records on status of ejection seats. j. Be prepared to discuss required ground support equipment and specialized tooling for maintenance. k. Be prepared to discuss and document the airframe fatigue life program compliance. l. Be prepared to discuss engine thrust measurement process. m. Be prepared to demonstrate oxygen system checks. n. If "G" suits are used be prepared to demonstrate serviceability. o. Have records for any fabricated parts and engineering documentation if required. p. Have records on flight control balancing. q. Have weight and balance records. r. Be prepared to discuss external stores. s. Be prepared to discuss Phase I test flights (recommended 10 hours). t. Have record of installed avionics. 3. Applicable regulations and ACs. a. §§ 21.93, 21.181, 21.193, 21.191(d), 23.1441, 43.3, 43.9, 45.11, 45.23(b), 45.25, 45.29, 91.205, 91.307, 91.319(a) (1), 91.407, 91.409(f) (4), 91.411, 91.413, 91.417, 91.1037, 91.1109, and AC 43-9, AC 91-79. 4. Items to discuss with applicant. a. Recommendation of establishing a minimum equipment list. b. Recommend establishing minimum pilot experience and proficiency, including (1) FAA PIC policy, NAVAIR training, (2) 10 to 15 hours of dual time, and (3) 3 hours per month, and five takeoffs and landings. c. Recommend establishing minimum runways length criteria for takeoff and landing. d. Discuss military use, that is, declaration of public use operations (PAO) and operating limitations.	

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T-38 Maintenance, Aircraft Inspection Program (AIP), and Servicing			
44.	Changes to Aircraft Inspection Program (AIP)	Consider whether the FAA-accepted AIP is subject to revisions to address safety concerns, alterations, or modifications to the aircraft. Section 91.415, Changes to Aircraft Inspection Programs, requires that "whenever the Administrator finds that revisions to an approved aircraft inspection program under § 91.409(f)(4) or § 91.1109 are necessary for the continued adequacy of the program, the owner or operator must, after notification by the Administrator, make any changes in the program found to be necessary by the Administrator." As provided by § 91.415, review the submitted maintenance manual(s) and AIP. Work with the applicant to revise the AIP as needed based on any concerns identified in attachment 3 to this document. For example, a T-38 AIP can be modified to address or verify— • Consistency with the applicable military T.O.s for airframe, powerplant, and systems to verify replacement/interval times are addressed. • All AIP section and subsections include the proper guidance/standards (that is, T.O.s or Engineering Orders) for all systems, groups, and tasks. • No "on condition" inspections for items that have replacement times unless proper technical data to substantiate the change, that is, aileron boost and oxygen regulator. • Ejection seat system replacement times are adhered to. No "on condition" inspections for rocket moors and propellants. Make the distinction between replacement times, that is, "shelf life" vs. "installed life limit." • Any deferred log is related to a listing of minimum equipment for flight (refer to *Minimum Equipment for Flight* below, and AFI 21-103); • Inclusion of document revision page(s).	
45.	AIP Is Not a Checklist	Ensure the AIP stresses it is not a checklist. This is important in many cases because the actual AIP is only a simple checklist and actual tasks/logbook entries say little of what was actually accomplished and to what standard. This is one of the major issues with some FAA-approved inspection programs, and stems from confusion about the different nature of (1) aircraft maintenance manuals, (2) AIPs, and (3) inspection checklists. Unless a task or item points to technical data (not just a reference to a manual), it is simply a checklist, not a manual. Ensure the AIP directs the reader to other references such as technical data, including references to sections and pages within a document (and revision level), that is, "AC 43-13, p. 318" or "inspection card 26.2." Records must be presented to verify times on airframe and engines, inspections, overhauls, repairs, and in particular, time in service, time remaining and shelf life on life limited parts. It is the owner's responsibility to ensure these records are accurate. Refer to Classic Jet Aircraft Association (CJAA) Safety Operations Manual, Rev. 6/30/08.	
46.	AIP Limitations	Refrain from assuming compliance with the applicable military standards, procedures, and inspections are sufficient to achieve an acceptable level of safety for civil operations, as part of the airworthiness certification and related review of the AIP. This may not be true, depending on the situation and the aircraft. For example, an AIP based on 1978 USAF requirements for the T-38 does not necessarily address the additional concerns or issues 35 years later, such as aging, structural and materials deterioration, stress damage (operations past life limits), extensive uncontrolled storage, new techniques, and industry standards.	
47.	AIP Revision Records	Ensure the applicant/operator retains a master list of all revisions that can be reviewed in accordance with other dated material that may be required to be done under a given revision. The AIP should address revision history for manual updates and flight log history.	
48.	Maintenance Responsibilities	The AIP should address responsibilities and functions in a clear manner. The AIP should address the difference between the aircraft owner and operator. The AIP also needs to address any leasing arrangement where maintenance is spilt or otherwise outside of the control of the applicant, that is, where maintenance is contracted to another party. The AIP should define the person responsible for maintenance. The AIP should address qualifications and delegations of authority, that is, whether the person responsible for maintenance has inspection authority and airworthiness release authority, or authority to return for service. In terms of inspection control and implementation, the AIP should define whether it is a delegation of authority, and if so, what authority is being delegated by the owner and operator. This has been an issue with the NTSB (and the Civil Aeronautics Board before it) since 1957.	
49.	Return to Service (RTS)	Ensure the AIP clearly defines who can return the aircraft to service and provides minimum criteria for this authority. Follow the intent and scope of § 43.5, Approval for return to service after maintenance, preventive maintenance, rebuilding, or alteration; and § 43.7, Persons authorized to approve aircraft, airframes, aircraft engines, propellers, appliances, or component parts for return to service after maintenance, preventive maintenance, rebuilding, or alteration.	

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50.	Maintenance Practices	Consider AC 43.13-2, Acceptable Methods, Techniques, and Practices-Aircraft Alterations, and AC 43.13-1, Acceptable Methods, Techniques, and Practices-Aircraft Inspection and Repair, in addition to any guidance provided by the manufacturer/military service(s), to verify safe maintenance practices.	
51.	Qualifications for Inspections	Ensure only FAA-certificated repair stations and FAA-certificated mechanics with appropriate ratings as authorized by § 43.3 perform inspections on the T-38.	
52.	Modifications	Verify major alterations conform to USAF guidance and do not create an unsafe condition, and determine whether new operating limitations may be required within the scope and intent of § 21.93. In addition, the information contained in appendix A to part 43 can be used as an aid. Refer to *Potential Reversion Back to Phase I* above. A USAF T-38 accident was the result of an undocumented modification. The report noted: "The mission was flown as a single-ship instrument training sortie. Takeoff and departure to the low altitude working area were uneventful. After approximately 22 minutes, the air traffic control center lost radio and radar contact with the aircraft. The center contacted the squadron, and the squadron initiated a radio and telephone search. Local residents and law enforcement personnel eventually located the aircraft wreckage. An Air Force helicopter was dispatched to the site to begin the investigation. Neither crewmember attempted to eject, nor both were fatally injured. The aircraft had been modified for a flight test 11 years before the mishap. Two holes and a notch were machined in the lower right wing to attach the flight test instruments. The aircraft was accepted and placed back in service without a study to determine the effect the holes and notch would have on the structural integrity of the right wing. A crack emanating from the notch was detected in the lower right wing skin 7 years before the mishap. The air logistics center designed a permanent wing repair, which was accomplished at the home base. A tool mark was introduced in the lower right wing skin near the area of repair when the wing was disassembled during overhaul. The wing was installed on the mishap aircraft 2 years later (5 years before the mishap). At some point, a fatigue crack developed at the tool mark. At an indeterminable G load during the mishap flight, the fatigue crack extended catastrophically chord-wise causing structural failure of the right wing. The resultant high G forces immediately incapacitated both crewmembers. The aircraft was destroyed upon ground impact, and both crewmembers were fatally injured. The mishap aircraft had been modified for special testing, which included modifications to the wing skin—a primary, load-bearing structure. Failure to determine the life expectancy of the wing before returning it to the active inventory indicated a serious deficiency in the logistics system. Inspection and acceptance procedures must be sufficient to reasonably assure a modified aircraft will remain airworthy during its normal life expectancy. Action Taken: Established a requirement for a thorough analysis of any aircraft having a modified primary structure before the aircraft is placed in the active Air Force inventory. The following excerpt from a NTSB report illustrates the dangers of certain types of modifications and inadequate standards, technical guidance, and testing: "On June 18, 2011, about 1450 Pacific daylight time, an experimental Aero Vodochody L-29 Delfin, N37KF, experienced the partial failure of the primary airframe structure supporting the airplane's rudder while in the air race pattern at Reno-Stead Airport, Reno, Nevada. The commercial pilot, who was the sole occupant, was not injured, but the airplane, which was owned and operated by Raju Mann Ward, sustained substantial damage. The local 14 Code of Federal Regulations Part 91 air race qualification/training flight, which took off from the same airport about 20 minutes before the accident, was being operated in visual meteorological conditions. According to the Federal Aviation Administration (FAA) inspector who responded to the scene, while the airplane was in flight, part of the engine support structure that had been installed as part of a modification to install a higher thrust engine, had failed to hold the new engine in proper alignment. That failure allowed jet blast from the engine to be deflected onto a portion of the primary airframe structure. The melting of that structure affected the support and movement of the airplane's rudder. Although the failure occurred in flight, it was not detected until the pilot was operating the rudder pedals during the landing roll. Although the pilot was able to keep the airplane on the runway, she had to apply alternative/non-standard control inputs to do so. During the investigation it was determined that at least five other L-29 airplanes had the same type of mounts, which were all designed, welded/manufactured by the same entity. According to the FAA inspector who looked at these mounts, the welding was poor on some of them, and there was some degree of structural variation between a number of the mounts."	
53.	Adequate Maintenance Schedule and Program (USAF TO 1T-38A-6-1)	Ensure the AIP follows USAF requirements, as appropriate, concerning inspections. Under USAF standards, the proper reference is the most current version of USAF TO 1T-38A-6, Aircraft Scheduled Inspection and Maintenance Requirements. A 1997 version of this document may not be sufficient to address some of the serious issues that aircraft has had since. For example, an April 4, 2003 version of this document (TO 1T-38A-6, Aircraft Scheduled Inspection and Maintenance Requirements, USAF Series T-38A, T-38B, and T-38C Aircraft, Change 1) is not the most current version. This is important when developing an inspection program under § 91.409. The inspection program must comply with both hourly and calendar inspection schedules. The only modifications to the military AIP should be related to the removal of military equipment and weapons. Deletions should be properly documented and justified. A 100-hour, 12-month inspection program under appendix D to part 43 may not be adequate for an aircraft like the T-38.	

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54.	Airframe, Engine, and Component Replacement Interval s	Verify compliance with required replacement intervals as outlined in appropriate and most current USAF inspection guidance. If components are not replaced per the military guidance, ask for data to justify extensions. Applicants should establish and record time-in-service for all life-limited components and verify compliance with approved life limits. Set time limits for overrun of intervals and track cycles. Evaluate any overruns of inspection or maintenance intervals.	
55.	Missing Inspection Tasks	Verify the AIP follows USAF requirements in terms of inspection tasks. It is imperative that no inspection tasks required by the military standard are removed. If they are removed, there should be adequate justification, and it cannot be solely cost-related. There have been several cases where an AIP did not conform to the applicable military standard and tasks were removed without adequate justification.	
56.	Hybrid Aircraft (General)	Verify the AIP is properly adjusted to reflect special situations such as hybrid aircraft. An example would be joining the front end of a T-38 with the back end of an F-5A to form a "T-38A/F-5A." It should not be assumed that only T-38 guidance is sufficient. The aft fuselage of the F-5 may incorporate additional or different requirements. One such example is the possible installation of a drag chute. Refer to *Drag Chute* below. Other differences, such as landing gear and fuselage structural elements will also have to be addressed.	
57.	Drag Chute (General)	If a drag chute is installed, verify it is done per the applicable USAF T.O. guidance (likely Northrop F-5A and F-5B guidance on installation, maintenance, and limitations), and the AIP reflects that installation. It is a critical safety of flight issue and needs to be inspected and maintained by trained personnel as per the applicable technical guidance and with adequate logbook entries. This includes re-packing after use, and those tasks properly documented. Repacking and re-installation of the drag chute is not a responsibility to be allocated to untrained personnel, and is not, as some operators have accepted "a pilot responsibility, normally accomplished as part of the preflight inspection and not logged in the maintenance records." There should be adequate technical data to validate the installation, See *Approved Drag Chute* and *Drag Chute and Systems Technical Guidance* below. Its use may also required special limitations. Note: There is information suggesting that drag chutes have been installed in T-38s (that is, N638TC), and this must be addressed. Also refer to *Drag Chute Installation and Use* below.	
58.	Drag Chute and Systems Technical Guidance	Verify that the technical guidance concerning the installation, maintenance and repacking of the drag chute and its systems (not just the chute itself). Relevant technical guidance includes: • USAF T.O. 391 and 392; • USAF T.O. 00-25-241 (see below). • NATO standards; • MS 21249A, *Military Standard: Handle, Control, Aircraft Drag Chute*, September 7, 1987.	
59.	USAF T.O. 00-25-241 (Chute Logs and Records)	Verify that, on the issue of the parachutes and drag chute, the AIP provides for the correct documentation and records keeping. USAF T.O. 00-25-241, *Parachute Logs, and Records,* February 1, 1997, Change 2, July 15, 1999, can be used if no other acceptable process is provided. The purpose of this technical order is to explain how to prepare, replace and dispose of AF T.O. Form 391, ''Parachute Log,'' and AF T.O. Form 392, ''Parachute Repack, Inspection and Component Record'' which are used to log and record parachute information. The use of these forms is highly recommended.	
60.	Parachute Data (Crew Parachutes)	Concerning parachutes, track parachute log books along with serial number, dates of manufacture and service life limits. The parachute must be packed, maintained, or altered by a person who holds an appropriate and current parachute rigger certificate. The certificate is issued under Title 14 of the Code of Federal Regulations (14 CFR) part 65, subpart F.	
61.	Appendix G to 14 CFR Part 23	Recommend appendix G to part 23 be used as a tool (not a requirement) because it can assist in the review of the applicant's proposed AIP and associated procedures and sets a good baseline for any review. NAVAIR guidance should also contain instructions for the continued airworthiness of the T-38. Appendix G to part 23 covers instructions for continued airworthiness.	
62.	Prioritize Maintenance Actions	Recommend the adoption of a risk management system that reprioritizes high-risk maintenance actions in terms of (a) immediate action, (b) urgent action, and (c) routine action. Also refer to *Recordkeeping, Tracking Discrepancies, and Corrective Action,* below.	

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63.	Cannibalization	Cannibalization is a common practice for several former military aircraft operators and service providers. The extent to which it takes place is not necessarily an issue, but keeping adequate records of the transfers, uses, and condition is. In 2001, the U.S. Government Accountability Office (GAO) published its findings on cannibalization of aircraft by the U.S. Department of Defense (DOD). It found cannibalizations have several adverse impacts. They increase maintenance costs by increasing workloads and create unnecessary mechanical problems for maintenance personnel. The GAO also found that with the exception of the Navy, the services do not consistently track the specific reasons for cannibalizations. In addition, a U.S. Navy study found cannibalizations are sometimes done because mechanics are not trained well enough to diagnose problems or because testing equipment is either not available or not working. Because some view cannibalization as a symptom of spare parts shortages, it is not closely analyzed, in that other possible causes or concerted efforts to measure the full extent of the practice are not made.	
64.	Recordkeeping, Tracking Discrepancies, and Corrective Action	Check applicant recordkeeping. The scope and content of §§ 43.9, 43.11, and 91.417 are acceptable. Recommend the use the USAF Form 781 process to help verify an acceptable level of continued operational safety (COS) for the aircraft. Three types of maintenance discrepancies can be found inside USAF Form 781: (1) an informational, that is, a general remark about a problem that does not require mitigation; (2) a red slash for a potentially serious problem; and (3) a red "X" highlighting a safety of flight issue that could result in an unsuccessful flight and/or loss of aircraft—no one should fly the aircraft until the issue is fixed. For more information on recordkeeping, refer to AC 43-9, Maintenance Records. T-38 procedures in AF T.O. Form 781, ARMS *Aircrew/Mission Flight Data Document, Review and Walkaround* guide aircraft airworthiness. Perform a walk around IAW the flight crew checklist. If any doubt exists as to the condition, settings, or operation of any system, consult a qualified maintenance representative."	
65.	Qualifications of Maintenance Personnel	Check for appropriate qualifications, licensing, and type-specific training of personnel engaged in managing, supervising, and performing aircraft maintenance functions and tasks. The NTSB has found the use of non-certificated mechanics with this type of aircraft has been a contributing factor to accidents. Only FAA-certificated repair stations and FAA-certificated mechanics with appropriate ratings as authorized by § 43.3 perform maintenance on this aircraft.	
66.	Ground Support, Servicing, and Maintenance Personnel Recurrent Training	Recommend regular refresher training is provided to ground support, servicing, and maintenance personnel concerning the main safety issues surrounding servicing and flight line maintenance of the T-38. Such a process should include a recurrent and regular review of the warnings, cautions, and notes listed in TO 1T-38B-2-1, Technical Manual General Airplane. Note: Ejection seat safety is paramount.	
67.	USAF Life Extension Program (LEP)	Ask the applicant if any of the components of the current USAF LEP for the T-38 have been incorporated into the aircraft. If not, it is recommended that LEP data, namely any structural upgrades (fuselage and wings), be considered.	
68.	Parts Storage and Management and Traceability	Recommend establishing a parts storage program that includes traceability of parts. This is important in the case of the T-38 because there might not be original equipment manufacturer (OEM) support for civil operators.	
69.	Maintenance Records and Use of Tech Data	Conduct a detailed inspection of maintenance records, as required by FAA Order 8130.2. Verify maintenance records reflect inspections, overhauls, repairs, time-in-service on articles, and engines. Ensure all records are current and appropriate technical data is referenced. This should not be a cursory review. Maintenance records are commonly inadequate or incomplete for imported aircraft. Refer to *Adequate T-38 Manuals and Related Documentation,* above.	
70.	J85/CJ610 Airworthiness Directives	Recommend the applicable Airworthiness Directives involving certificated versions of the J85, the CJ610 engine, be considered as part of the AIP. These may include safety issues that may have to be addressed, especially in cases involving the J85-5, which is an earlier version of the engine.	
71.	Airframe Limitations and Durability	Verify whether the AIP addresses the T-38's airframe limits, how total time is kept, and the status of any extension. Verify the appropriate data is available to consider an extension past the USAF life limit for the airframe and wings. The T-38 under normal military use has a 20-year airframe life. Military T-38s (including NASA models) undergo continuous modification and upgrade to remain safe for flight. USAF modifications have included new wings (twice), addition of steel longerons in the fuselage aft of the cockpit, engine upgrades, changes to the intakes, and a complete rebuild of the forward fuselage (currently in progress). The wing replacement fleet wide in 1985 cost $650 million for the parts. The current forward fuselage rebuild will cost $460 million for the parts for 380 aircraft, plus 14,000 man-hours per aircraft for installation. The USAF plans to extend the service life to 2040 with these upgrades. This should be considered when evaluating inspection requirements and operating limitations for an unmodified or original T-38, especially when the origin of parts such as the fuselage, wing, or tail surfaces is unknown.	

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72.	"On Condition" Inspections	Adhere to the military/manufacturer program and/or provide adequate data to justify that practice for the applicable part or component if "on condition" inspections are considered. "On condition" must reference an applicable standard (that is, inspect the fuel pump to an acceptable reference standard, not just "it has been working so far"). Each "on condition" inspection must state acceptable parameters. "On condition" inspections are not appropriate for all parts and components.	
73.	Aging	Verify the AIP addresses the age of the aircraft. This means many, if not all, of the age effects have an impact on the aircraft, including: (1) dynamic component wear out, (2) structural degradation/corrosion, (3) propulsion system aging, (4) outdated electronics, and (5) expired wiring. Note: The T-38 trainer aircraft was either designed to be damage tolerant using the safe crack growth concept or later analyzed on the basis of crack growth to establish safety limits and inspection requirements. This was accomplished during the durability and damage tolerance assessments (DADTA) that were performed on these aircraft. As such, with increasing age the primary threat to their structural safety is the growth in fatigue-critical areas and the potential of missing one or more of these areas. Refer to *Aging of U.S. Air Force Aircraft.* Publication NMAB-488-2, NATIONAL ACADEMY PRESS, Washington, D.C., 1997.	
74.	Use of Cycles (General)	Recommend the AIP provides for tracking cycles, such as airframe and engine cycles, in addition to time and in combination with inspections. This allows for the buildup of safety margins and reliability. In military jet aircraft like the T-38, there is a relationship between parts failures, especially as they relate to power plants, landing gears, and other systems, and for that reason it is very important to track airframe and engine cycles between failures and total cycles to enhance safety margins. For example, tracking all aircraft takeoffs for full-thrust and de-rated thrust takeoffs as part of the inspection and maintenance program would be a good practice and can assist in building up reliability data. The occurrence of failures can be meaningfully reduced, and cycles can play an important role. When rates are used in the analysis, graphic charts (or equivalent displays) can show areas in need of corrective action. Conversely, statistical analysis of inspection findings or other abnormalities related to aircraft/engine check and inspection periods requires judgmental analysis. Therefore, programs encompassing aircraft/engine check or inspection intervals might consider numerical indicators, but sampling inspection and discrepancy analysis would be of more benefit. A data collection system should include a specific flow of information, identity of data sources, and procedures for transmission of data, including use of forms and computer runs. Responsibilities within the operator's organization should be established for each step of data development and processing. Typical sources of performance information are as follows, however, it is not implied that all of these sources need be included in the program nor does this listing prohibit the use of other sources of information: • Pilot reports, • In-flight engine performance data, • Mechanical interruptions/delays, • Engine shutdowns, • Unscheduled removals, • Confirmed failures, • Functional checks, • Bench checks, • Shop findings, • Sampling inspections, • Inspection discrepancies, and • Service difficulty reports.	
75.	Inspect and Repair as Necessary (IRAN)	If an IRAN is utilized, verify it is detailed and uses adequate technical data (that is, include references to acceptable technical data) and adequate sequence for its completion if it is proposed (there was a T-38 IRAN program in the USAF). An IRAN must have a basis and acceptable standards. It is not analogous to an "on condition" inspection. It must have an established level of reliability and life extension. An IRAN is not a homemade inspection program.	
76.	M1 Support Services	Ask the applicant if M1 Support Services has been involved in the restoration of the aircraft back to airworthiness status. This might be relevant because that company provides such services to the USAF. If so, ask for documentation of any work performed.	
77.	Combining Inspection Intervals Into One	Set time limits for overrun (flex) of inspection intervals in accordance with the applicable USAF guidance.	
78.	Aircraft Storage and Returning the Aircraft to Service After Inactivity	Verify the applicant has a program to address aircraft inactivity and specifies specific maintenance actions for return to service per the applicable USAF T-38 inspection schedule(s) (for example, after 31 days). The aircraft should be housed in a hangar during maintenance. When the aircraft is parked in the open, it must be protected from the elements, that is, full blanking kit and periodic anti-deterioration checks are to be carried out as weather dictates.	

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79.	Specialized Tooling for T-38 Maintenance	Verify adequate tooling, jigs, and instrumentation is used for the required periodic inspections and maintenance per the T-38 maintenance manuals.	
80.	Technical Orders Issued While in Service	Verify the AIP references and addresses the applicable USAF T.O.s issued to the T-38 during military service to address airworthiness and safety issues, maintenance, modifications, updates to service instructions, and operations of the aircraft.	
81.	Time Critical Technical Orders (TCTO) and TO 00-5-15	Verify the AIP specifically accounts for, addresses, and documents the applicable TCTOs issued to the T-38 while in service. Compliance with the TCTOs is essential for safe operations. If the AIP only makes reference to a few TCTOs issued in 1976, for example, it would not be adequate. The guiding document is TO 00-5-15.	
82.	USAF T-38 Safety Supplements	Verify the applicant/operator has copies of the applicable safety supplements for the T-38 and they are incorporated into the AIP or operational guidance as appropriate.	
83.	Corrosion Due to Age and Inadequate Storage	Ask whether a corrosion control program is in place. If not, ask for steps taken or how it is addressed in the AIP. Evaluate adequacy of corrosion control procedures. Age, condition, and types of materials used in the T-38 require some form of corrosion inspection control. The use of TO 1T-38A-23, Corrosion Control, USAF Series T-38A and T-38B Aircraft, is required. Recommend the use of TO 1-1-691, Corrosion Prevention and Control Manual. Note: When in 1980, the USAF returned T-38s from the 26th Tactical Fighter Training Aggressor Squadron (which had been operating from Clark Air Base) to the United States; the aircraft were sent to permanent storage due to extensive corrosion and were later sold as scrap.	
84.	TCTO 1T-38A-889	Verify whether the AIP addresses TCTO 1T-38A-889. This TCTO covers the modifications made too many T-38s to take the aircraft to the AT-38 standard. Ensure the weapon elements of the modification are addressed (demilitarization) and any additional components or equipment are not missed as part of the AIP.	
85.	Pylons (Structural)	If applicable and installed (in AT-38s), verify the AIP addresses the inspection of the aircraft's centerline pylons per the applicable USAF guidance from a structural standpoint, including checking them for cracks.	
86.	J85-17A Engine Maintenance Procedu res	Verify the AIP adheres to the USAF maintenance procedures requirements per the applicable version of USAF TO 1T-38B-2-5, Power Plant, as the T-38 is equipped with the General Electric J85-GE-17A.	
87.	Manufacturer's and/or USAF Engine Modifications	Verify the AIP addresses the incorporation of the manufacturer and USAF modifications to the J85 engine installed. The NTSB and some foreign CAAs have determined a causal factor in some accidents is the failure of some civil operators of former military aircraft to incorporate the manufacturer's recommended modifications to prevent engine failures.	
88.	Cycles and Adjustment J85-5 Engine Replacement Intervals	Ask if both engine cycles and hours are tracked. If not, recommend it be done.	
89.	J85 Failures and Failure Modes	Verify the AIP discusses the known J85 failure and failure modes, including— • Engine VG systems, • Flameouts, • Stuck exhaust nozzles, • No. 2 bearing, • Stage-two turbine wheel failures (refer to *J85 Stage-Two Turbine Wheel Failures* below), and • Eighth-stage disk corrosion (refer to *J85 Eighth-Stage Disk Life Limit (Corrosion)* below).	

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90.	J85 Engine Components Life Limits	Verify the AIP addresses the life limit of J85 engine components. "On condition" inspections are not acceptable. The following T-38 accident summary illustrates this point: "The mishap aircraft was on a dual contact training mission. The crew had just completed a straight-in, touch-and-go landing. As the aircraft became airborne, they heard a 'bang' and began to smell smoke. The right engine fire light illuminated, and the crew noted the engine rpm at 20 percent. As the crew shut down the right engine, they noticed the left engine fire light was also illuminated. The IP started a climb, but lost all pitch control passing 1,500 feet AGL. The crewmembers ejected passing 2,000 feet AGL and were uninjured. The aircraft was destroyed upon impact. The fifth-stage disk-life cycle did not provide an adequate safety margin. Unit supervisors throughout the command failed to ensure that material deficiency reports were submitted on all cracked or failed fifth stage disks. As a result, the engine manager was unaware of any problem. Otherwise, he might have reduced the life cycle. The mishap engine's fifth-stage disk had developed a low-cycle fatigue crack, leading to catastrophic failure on the mishap sortie. The disk fragments penetrated the engine case and ruptured the fuel lines. Escaping fuel ignited on the hot section of the engine, causing the right engine fire light to illuminate. Although the crew shut down the right engine, the fire continued to burn and damaged the pitch control mechanism. Lesson Learned: Properly reporting material deficiencies can prevent accidents. It would likely have prevented this fifth-stage disk from remaining in the aircraft until failure. Action Taken: Emphasized material deficiency reporting procedures." Refer to *J85 Stage-Two Turbine Wheel Failures* and *J85 Eighth-Stage Disk Life Limit* below.	
91.	J85-5 Engine Inspections and Time Between Overhaul (TBO)	Verify the applicant has established the proper inspection intervals and TBO/replacement interval for the specific engine type and adhere to those limitations and replacement intervals for related components. Justification and FAA concurrence is required for an inspection and TBO above those set in the appropriate T-38/engine inspection guidance. Clear data on TBO/time remaining on the engine at time of certification is critical, as is documenting those throughout the aircraft life cycle. Note: The USAF has upgraded the engines/intakes on the T-38. It is important to know which series J85 is installed and use the appropriate operating manuals and technical references. J85 engine inspection includes— • Engine performance analysis, • Hot section inspection, • Balancing/rotating components, • Thermal barrier coatings, • Turbine Shaft, • Compressor, • Exhaust duct, • Inner shell and outer shell, • Radial diffuser, • Turbine housing, and • Compressor housing.	
92.	Failure Analysis of J85 Engine Turbine Blades	Recommend Failure Analysis of J85 Engine Turbine Blades be considered as part of the J85 engine related inspection and maintenance. This paper "analyzes the cause of the engine damage due to the fracture of the J85 Engine first stage turbine blades. Discoloration due to thermal effect and fine multi-cracks as well as necking at 1/3 of the way down from the tip on the entire first stage turbine blade concave side surface have been noted. Of the first stage blades, nine had fractures 1/3 of the way down from the tip, and at the fractured location more severe necking has been found than blades without fracture. As a result of observing the fine texture of fractured blades and the blades where deformation has occurred, wedge-type inter-granular cracks and TCP phase as well as carbide phase have been identified, and *y* deformation and depletion found around the fracture surface. There were no traces of thermal damage to the first stage vane, no IOD phenomenon has been noted. Analysis of turbine blade deformation and fracture profile and micro-structural deformation phenomenon determined that blade fracture was due to high temperature creep rupture." Refer to Seen-gab Kim, *Failure Analysis of J85 Engine Turbine Blades,* Department of Mechanical Engineering, Kyungpook National University, Daege 702-701, Republic of Korea, 2007.	

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93.	J85 Stage-Two Turbine Wheel Failures	Verify the AIP addresses the inspection, per the latest USAF requirements (including changing inspection schedules), of the stage-two turbine wheels. "On condition" inspections are not acceptable. A T-38 accident illustrates this failure: "The mission was flown by two IPs on a cross-country flight. The RCP pilot completed a normal rolling takeoff. After liftoff, both pilots heard a loud bang as the RCP pilot retarded the throttles out of afterburner. The RCP pilot noted the left engine rpm decaying through 40 percent and retarded the throttle to idle. The FCP pilot assumed command of the aircraft and declared an emergency. The right fire light illuminated 3 to 4 seconds later, and the aircraft began a slight roll to the left with an un-commanded pitch-up. The FCP pilot commanded ejection as he lost aircraft response, and both crewmembers ejected successfully. Investigation (Material Factor): The stage two turbine wheel on the left engine developed a crack as a result of a machining defect. During initial takeoff, the stage two turbine wheels failed, causing an uncontained engine failure. Turbine parts penetrated the engine firewall, allowing hydraulic lines to be exposed to hot combustion gases. The hydraulic lines burned through depleting pressure in both hydraulic systems. The aircraft became uncontrollable as the hydraulic pressure depleted. Lesson Learned: This is just another reminder of just how quickly a situation can deteriorate. The transfer of aircraft control happened at a critical stage. However, it was done correctly and did not impact the outcome. The crew made a timely decision to eject, and both were uninjured. Action Taken: Conducted an urgent engineering analysis on stage-two turbine wheels to identify necessary corrective actions and prevent future occurrences. Performed a research study to determine the feasibility of implementing a nondestructive inspection technique to detect turbine-wheel cracks." Another T-38 involved the stage-two turbine wheel: "The mission was a single-ship navigation sortie flown by an IP and a first pilot (FP). The crew heard a loud pop or bang on the departure leg of the initial takeoff. (The throttles were still in afterburner). The crew analyzed the indications as a compressor stall, and the FP retarded the left throttle to idle. The fire light illuminated a short time later. The FP confirmed the fire light with the IP and shut down the engine, using appropriate boldface procedures. However, the fire light remained on. The left hydraulic pressure was zero as the left engine wind milled at 20 to 22 percent rpm. The FP initiated a turn to downwind, set up for a straight-in approach, and declared an emergency. The IP assumed control of the aircraft for the pattern and landing IAW the brief. The crew noted no other indications of a fire, and tower personnel did not see any smoke or flames trailing the mishap aircraft. The IP began having problems controlling the pitch, but had good aileron control. He transferred control of the aircraft back to the FP to see if he could control the pitch, but he could not. The right hydraulic pressure began to decrease, and the ailerons ceased to respond. The crew ejected successfully, but the aircraft was destroyed upon impact. Miscellaneous Factor: At an unknown time, the second-stage compressor disk was exposed to corrosive elements, causing pitting in the bore section. Logistics and Material Factor: Previous specifications for the aft section flexible hydraulic hoses included inferior material which melted at a temperature of 400 degrees F to 500 degrees F. Material Factor: The second-stage compressor disk failed catastrophically on the departure leg, penetrating the engine case, dislodging a fuel line, severing a hydraulic line, and igniting fuel and hydraulic fluid in the engine bay. Lesson Learned. The inspection cycle for J85 engine compressor disks was too long, hampering corrosion or crack detection prior to failure. Action Taken: Modified the J85 engine by installing a redesigned and sturdier second-stage disk. Compressed time change requirements for the second stage disk. This was more effective at alleviating the problem than decreasing time between inspections."	

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94.	J85 Eighth-Stage Disk Life Limit (Corrosion)	Verify the AIP addresses the change in the eight-stage disk life limit per the latest USAF requirements. "On condition" inspections are not acceptable. The following T-38 accident shows why: "The mission was dual contact and was the SP's ninth sortie in the T-38. The IP was well experienced. The SP retarded the throttles out of afterburner just after takeoff at approximately 100 feet AGL and 240 knots. The crew heard a loud bang as the SP retarded the left throttle. An aircraft offset from the runway noticed a fireball from the left side of the mishap aircraft. The left rpm dropped to zero, and the left hydraulic and generator caution lights illuminated. The left fire light illuminated about 1 second later. The IP took control of the aircraft, brought the left throttle to idle, and selected afterburner on the right engine. A chase aircraft informed the crew that there was no smoke or fire coming from the mishap aircraft. The aircraft then began an un-commanded pitch- up, and the right fire light illuminated for a few seconds. The IP pushed the nose over, but the aircraft would not level out. The IP commanded an ejection, and the crew ejected successfully with minor injuries. The aircraft was destroyed upon impact. Logistics Factor: The eighth-stage compressor disks in the J85 engine were susceptible to corrosion, which led to fatigue failures. Although the corrosion was a known problem, the frequency of disk failures was so low it was difficult to accurately predict the severity. A historical survey after this incident indicated eighth-stage disk failures typically resulted in uncontained engine failures, in-flight fires, hydraulic and fuel line burn-through, and eventual loss of aircraft control. Prior to this, leadership had considered the corrosion and possible disk failure an acceptable risk due to the low probability. Logistics Factor: Logistics managers failed to implement a mandatory recurring inspection of the J85 eighth-stage compressor disks. Also, Logistic managers did not direct inspectors to use newly developed inspection methods. Lesson Learned: Although catastrophic failures during a critical phase of flight are infrequent, they do happen. In this situation, there was nothing the crew could do to stop the chain of events that started with the disk failure. This mishap also highlighted the difficulty in making risk assessments involving low probability, but high severity. When doing your own personal risk assessments, be sure to critically evaluate the consequences, even if the probability is very low. If your decision could even remotely lead to loss of aircraft (or possible loss of life), take time to reconsider. Action Taken: Reduced the eighth-stage disk's life limit, implemented nondestructive inspections to identify corrosion and fatigue, and began process to re-design and replace old disks with new, non corrosive disks."	
95.	Engine Check	Verify the AIP includes adequate USAF procedures, including checks and signoffs for returning an aircraft to airworthiness condition after any work on the engine. As an example, as part of its investigation of a fatal former military aircraft accident in 2004, the NTSB found after an engine swap-out the week before the fatal accident, the mechanics had warned the newly installed engine was not operating correctly. The record also shows the A&P mechanic who oversaw and supervised the engine change did not sign off any maintenance records to return the airplane to an airworthy status. Before the fatal flight, two engine acceleration tests failed, and multiple aborted takeoffs took place in the days leading up to the crash.	
96.	Engine Thrust	Verify the AIP includes measuring actual thrust of the engine and tracking engine operating temperatures. Original GE J85 engines and intake assemblies did not provide the amount of thrust current USAF T-38s do. The USAF's J85 has been upgraded along with larger intakes resulting in improved thrust. The operator should be aware of this when contacting Northrop or GE for support. Refer to *Jet Thrust Laboratory*, MAE 650:432 Mechanical Engineering Laboratory, Department of Mechanical, and Aerospace Engineering, Rutgers: The State University of New Jersey at http://coewww.rutgers.edu/classes/mae/mae432/Lecture-Lab1.pdf. For an operational impact perspective, also recommend Daidzic, Nihad. Jet Engine Thrust Ratings. *Professional Pilot,* Vol. Vol. 46, No. 9 (September 2012).	
97.	J85 Afterburners and Nozzle	Verify the AIP specifically addresses the inspection of the J85 afterburner system and the augmentor nozzle and related actuators. Engine problems, such as stuck exhaust nozzles that overheated engines, led to 47 Class C mishaps in 2007. Afterburner components are items of interest for T-38 operators, as noted by the following ad: "I am looking to purchase 4 variable exhaust nozzle actuators for the afterburner on the GE J85 engine. I am also interested in purchasing the flexible drive shafts which synchronize these actuators." http://www.avitop.com/cs/forums/thread/10909.aspx.	

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98.	T-38 Propulsion Modernization Program (PMP) (J85-5R Engine)	Ask whether the aircraft has any of the new USAF T-38 Propulsion Modernization Program (PMP) upgrades installed. If so, ensure the AIP is adjusted accordingly. The most notable modification involved the replacement of stage two compressor blades. Note: The USAF awarded a 10-year contract worth $601 million to GE Aircraft Engines to modify the J85-5 turbojet engines on the fleet of 509 aircraft. The contract included the delivery of 1,202 J85-5 modification kits and 509 engine ejector nozzles. The first aircraft, with the engine upgrade, was delivered in November 2002. The J85-5R is the correct reference after the modification. These -5R upgrade kits, as they are known, "comprises an improved technology 'spooled' compressor rotor and stator assembly, a single-piece cast mainframe, upgrade components for the high-pressure turbine section, an improved afterburner liner and a new exhaust ejector nozzle to achieve higher net thrust at takeoff and lower fuel consumption throughout the aircraft flight envelop….the new eight-stage compressor rotor assembly, which can be readily installed, sharply reduce engine life-cycle costs through improved durability and lower parts count, and by allowing individual blade replacement without rotor disassembly." Gething, *USAF's Talons*, 2002. A USAF review of this program noted that "the PMP led to the design and implementation of an enlarged inlet which resulted in a 20% ground static thrust increase; 12-15% decreased takeoff roll; and a single engine climb performance increase of 250 ft/min at normal takeoff weights. Additionally, the new ejector with a standard air inlet modification improves fuel consumption by 10 to 12 percent while in cruise flight at FL 400. The new ejector also showed a 3% increase in military (MIL) power thrust at low altitude and up to 8% at higher altitudes. Finally, the takeoff performance improved by approximately 3%. The new ejector with new inlet combination also resulted in improvements. The static takeoff thrust increased by 19% MIL power and 19.5% maximum (MAX) power. Ground roll improved from 6.8% at 39°F to 19.9% at 82°F. Further improvements: all air starts were successful, all throttle transients were absorbed without problems, no engine roll-back susceptibility was found, and the engine exhibited stall free operation in maneuvering flight throughout the envelope. Finally, takeoff limitations due to hot summer months will be reduced permitting an increase in operational training. The improved engine has increased takeoff thrust, been compressor-stall free, and exhibited no roll back susceptibility in testing. Air Force safety surveillance and reduced contractor maintenance actions increased the MTBF, should result in less human error, an increase in reliability, and fault reduction." Refer to http://www.wpafb.af.mil/shared/media/document/AFD-090121-037.pdf.	
99.	Use of Different Fuels	Verify the AIP addresses how the use of different fuels may require changes or additions to the J85-5 engine inspection and maintenance programs. These types of data should be available because the USAF has operated the aircraft since 1959 and has, over the years, introduced many different types of fuels, namely JP-1, JP-4, JP-5, and JP-8.	
100.	Engine Ground Run	Verify the engine goes through a ground run and check for leaks after reassembly. Confirm it achieves the required revolutions per minute for a given exhaust gas temperature (EGT), outside air temperature, and field elevation.	
101.	Fire Detection System	Verify the serviceability of the fire detection system. This is no fire extinguishing system in the T-38. However, there are two temperature sensors in the engine compartment for each engine, one in the engine section and one in the boat tail section. The operator should establish an inspection process (reference USAF T.O.s) to ensure the validity of the fire warning system.	
102.	Servicing, Engine Fire Servicing Personnel Unfamiliar With the T-38 Create Hazardous Situations	Ensure the operator warns servicing personnel via training and markings of the fire hazard of overfilling oil, hydraulic, and fuel tanks. Lack of experience with T-38 servicing is a safety concern. Require supervision of servicing operations and fire safety procedures.	
103.	Fire Guard	Verify maintenance, servicing, preflight, and post-flight activities include fire guard precautions. This is a standard USAF safety-related procedure.	
104.	Engine Start	Verify the AIP includes procedures for documenting all unsuccessful engine starts.	
105.	Engine Storage	Review J85 engine storage methods and determine engine condition after storage. Evaluate calendar time since the last overhaul. For example, the use of an engine with 50 hours since a 1991 overhaul may not be adequate and a new overhaul may be required after a specified time in storage. Note: Experimental exhibition of former military aircraft is that engines that have exceeded storage life limits are susceptible to internal corrosion, deterioration of seals and coatings, and breakdown of engine preservation lubricants.	
106.	Wiring Diagram and Inspection	Verify the AIP includes up-to-date wiring diagrams consistent with USAF guidance and includes the appropriate inspection procedures. Any reference to the applicable guidance must address modifications. In addition to the appropriate T-38 TO on wiring, TO 1T-38A-2-8, another reference is NA 01-1AA-505, Joint Service General Wiring Maintenance Manual. Note: Extensive wiring work was performed in USAF T-38s as part of the Pacer Classic programs.	

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107.	Engine Foreign Object Damage (FOD)	Verify adoption of an FOD prevention program (internal engine section, external, and air intake). Use and properly inspect the air intake screen (FOD guards) provided with the aircraft and designed for the T-38.	
108.	Engine Condition Monitoring (Oil Analysis)	As part of the engine maintenance schedule, recommend an engine Spectrographic Oil Analysis Program (SOAP) be implemented with intervals of less than 15 hours. If baseline data exists, this can be very useful for failure prevention. If manufacturer baseline data does not exist, this may still warn of impending failure. For the latest guidance on SOAPs affecting the J85, refer to Joint Oil Analysis Program Manual, Volume III: Laboratory Analytical Methodology and Equipment Criteria. (Aeronautical) (Navy) NAVAIR 17-15-50.3, (Army) TM 38-301-3, (Air Force) TO 33-1-37-3, and (Coast Guard) CGTO 33-1-37-3, dated July 31, 2012. This document presents the methodology for evaluating spectrometric analyses of samples from aeronautical equipment. The methodology enables an evaluator to identify wear metals present in the sample and their probable sources, judge equipment condition, and make recommendations that influence maintenance and operational decisions. Following these recommendations can enhance safety and equipment reliability and contribute to more effective and economic maintenance practices.	
109.	Engine Bleed Air	Verify the AIP includes procedures for inspecting and ensuring the serviceability of the engine bleed air system.	
110.	Fuel Tank Inspections and Related Structures	Verify the AIP includes procedures for inspecting the fuel tanks (and related structures). Deterioration of the fuselage bladder tank (bag) and the sealant can pose a safety problem, especially because of the aircraft's age and storage, as well as the difficulty of the inspection (and access to the fuel tanks) itself. Bladder-type fuel tank safety is not necessarily ensured by only "on-condition" inspections and may require more extensive processes, including replacements. In any event, adequate data must be provided for any justification to inspect rather than replacing the fuel tanks at the end of their life limit.	
111.	Broken Systems (Fuel, Oil, and Hydraulic) Lines	Verify the AIP includes procedures for inspecting and replacing fuel, oil, and hydraulic lines according to the applicable USAF requirements; for example, MIL-DTL-8794, and MIL-DTL-8795 specifications.	
112.	Systems Functionality and Leak Checks	Verify procedures are in place to check all major T-38 systems in the aircraft for serviceability and functionality. Verify the leak checks of all systems are properly accounted for in the AIP per the USAF requirements.	
113.	Oil, Fuel, and Hydraulic Fluids	Verify procedures are in place to identify and use a list of equivalents of materials for replacing oil, fuel, and hydraulic fluids. Many operators include a cross-reference chart for NATO and U.S. lubricants as part of the AIP.	
114.	Electrical System and Batteries	Verify functionality of the generator and the compatibility of the aircraft's electrical system with any new battery installation or other system and component installation or modification. Avoiding overload conditions is essential because this is a known problem with the aircraft's electrical system.	
115.	Borescope Engine	Recommend the AIP incorporate borescope inspections of the engine at 50 hours per the applicable inspection procedures. AC 43.13-1 can be used as a reference.	
116.	Pitot/Static, Lighting, and Avionics and Instruments	Verify compliance with all applicable 14 CFR requirements (that is, § 91.411) concerning the pitot/static system, exterior lighting (that is, adequate position and anti-collision lighting), transponder, avionics, and related instruments.	
117.	Pitot Tube	Verify the AIP addresses the proper inspection of the pitot tube system. T-38 pitot tubes have failed in the past. In one accident, it was found that "the pitot heat failed during flight because of circuit discontinuity, which was probably due to carbon deposits on the contacts in the pitot heat switch. As a result, the pitot tube accumulated ice, causing an airspeed indicator system malfunction."	
118.	Oxygen System	Emphasize inspection of the oxygen system and any modifications. Compliance with § 91.211, Supplemental Oxygen, is required. Recommend adherence to § 23.1441, Oxygen Equipment and Supply. Moreover, per FAA Order 8900.1, change 124, chapter 57, Maintenance Requirements for High-Pressure Cylinders Installed in U.S. Registered Aircraft Certificated in Any Category, each high-pressure cylinder installed in a U.S.-registered aircraft must be a cylinder manufactured and approved under the requirements of 49 CFR, or under a special permit issued by the Pipeline and Hazardous Materials Safety Administration (PHMSA) under 49 CFR part 107. There is no provision for the FAA to authorize "on condition" for testing, maintenance, or inspection of high-pressure cylinders under 49 CFR (PHMSA).	

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119.	Other Pressure Cylinders	Emphasize the proper inspection of any pressure cylinders. Per FAA Order 8900.1 change 124, chapter 57, each high-pressure cylinder installed in a U.S.-registered aircraft must be a cylinder that is manufactured and approved under the requirements of 49 CFR, or under a special permit issued by PHMSA under 49 CFR part 107. There is no provision for the FAA to authorize "on condition" for testing, maintenance or inspection of high-pressure cylinders under 49 CFR. For example, the fire bottles are time sensitive items, and may have a limit of 5 years for hydrostatic testing. The issue is when the bottles are removed from the aircraft. It is industry knowledge that non-U.S. bottles may be installed as long as they are within their hydrostatic test dates. A problem arises when removing the bottles for hydrostatic testing. Maintenance programs require these bottles to be hydrostatic tested. Once the non-U.S. bottles are removed from the aircraft, they are not supposed to be hydrostatic tested, recharged, or reinstalled in any aircraft. Moreover, those bottles cannot be serviced (on board) after the testing date has expired.	
120.	Anti-G Suit System	Verify the serviceability of both aircraft systems (that is, anti-G valve) and the anti-G suit, if installed. There have been instances of anti-G valves being stuck in the open position. If the anti-G valve fails, it can blow scorching hot air into the cockpit. Note: A G suit, or the more accurately named anti-G suit, is a flight suit worn by aviators and astronauts who are subject to high levels of acceleration force (G). It is designed to prevent a blackout and G-induced loss of consciousness (G-LOC caused by the blood pooling in the lower part of the body when under acceleration, thus depriving the brain of blood. Blackout and G-LOC have caused a number of fatal aircraft accidents.	
121.	Pressurization Vessel and Environmental Control	Verify the AIP incorporates the inspection of the pressurized sections of the aircraft. Note pressure cycles and any repairs in the area. Verify the AIP incorporates related documentation and manuals. The following excerpt from TO 1T-38-1 provides more details on this critical system: "The Cabin Pressure Indicator on the FCP instrument panel indicates the pressure altitude within the cabin. All controls in the air conditioning and pressurization system, except the canopy defog, are electrically (AC) controlled. The canopy defog is pneumatically controlled and does not require AC power. The cabin pressure regulator maintains cabin pressure at relative 0 PSI differential at altitudes below 8000 feet. Between 8000 feet and approximately 23,000 feet, the regulator maintains a cabin pressure corresponding to 8000 (+/-1000) feet. Above 23,000 feet, the regulator maintains a pressure differential of 5 PSI above ambient pressure (+/-2000). A guarded Cabin Pressure Switch is located on the right console of the FCP. The switch controls cabin air conditioning and pressurization. When the switch is placed in CABIN PRESS, both the cabin air conditioning and pressurization systems are activated. When the cabin pressure switch is placed in RAM DUMP, the anti-g suit, canopy defog, cabin pressurization and air-conditioning systems and canopy seal are deactivated, and ram air enters the cabin for ventilating purposes. Placing the cabin pressure switch in RAM DUMP does not deflate the canopy seal, but prevents air flow into the seal. The seal remains inflated for an undetermined amount of time. Normal seal deflation is provided by a switch activated by opening the canopy locking lever, provided AC power is available. Vibrations accompanied by fumes and/or odors from the air conditioning system may indicate air conditioner turbine failure. If this condition is suspected, select oxygen - 100%, descend below 25,000 feet, and select RAM DUMP to deactivate the air conditioning system. This should stop the vibrations. To eliminate cabin air conditioning duct howl with the RCP cabin air inlet valve closed, adjust either the FCP cabin air inlet valve toward the closed position or adjust the RCP cabin air inlet valve toward the open position." Also refer to *Upper Deck* below.	
122.	Cockpit Instrumentation Markings	Verify all cockpit markings are legible and use proper English terminology and units acceptable to the FAA. The T-38 was delivered with traditional "round" dial gages. The AIP should address inspection of all cockpit instruments with regular intervals for each subsystem. Care should also be taken to inspect modifications, including communications, navigation, or other upgrades to the cockpit. The AIP should address a cockpit indicator calibration process to ensure accurate indications for essential components.	
123.	Caution Light System	The AIP should include steps to verify and maintain the integrity of the caution light systems in the T-38. This is especially important due to the age of the components and the technology used in the 1960s.	
124.	T-38 Safety Markings and Stenciling	Verify appropriate safety markings required by T-38 technical manuals (that is, stenciling and "Remove Before Flight" banners) have been applied and are in English. These markings provide appropriate warnings/instruction regarding areas of the aircraft that could be dangerous. These areas include intakes, exhaust, air brakes, and ejection seats. In the case of ejections seat systems, and as noted in FAA Order 8130.2, paragraph 4074(e), "a special airworthiness certificate will not be issued before meeting this requirement."	
125.	Installation of Smoke Oil Tanks	Any installation of smoke oil tanks should only be done in accordance with USAF modification procedures for the T-38 used for the Thunderbird demonstration team. Refer to USAF TO 1T-38A-1-2, figure 1-10. Note: The USAF Thunderbirds acrobatic team used the T-38 from 1974 until 1982.	

#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
126.	Cockpit FOD	Verify the AIP addresses thorough inspection and cleaning of the cockpit area to preclude inadvertent ejection, flight control interference, pressurization problems, and other problems. This is a standard USAF practice. For the T-38, the USAF guidance entitled *Canopy Management and FOD* notes that "with so many items potentially cluttering the cockpit during a cross-country mission, you may want to leave the canopies closed until engine shutdown. In any case, double-check to ensure all loose items are accounted for and secure before opening the canopies." In addition, the T-38 aircraft flight manual (AFM) (or "-1," the TO number for AFM) notes that "hard items stored under the seat can puncture the cockpit floor when the seat is lowered resulting in the loss of cabin pressurization."	
127.	Tires and Wheels	Verify use of proper tires and/or equivalent substitutes (including inner tubes) and adherence to any tire limitation, such as allowed number of landings, inflation requirements, and the use of retreaded tires. The type of tire may dictate the number of landings. Wheels must be properly and regularly inspected and balanced. The T-38 has a long history of tire failures, one of the leading causes of accidents. The following accident narrative illustrates the consequences of a tire failure: "The mishap sortie was a CT mission for the IP in the RCP. The mishap crew was executing a no-flaps touch and go with a left crosswind of 19 knots. The RCP IP heard a loud bang soon after touchdown and determined the left tire had blown. He initiated an abort by bringing the throttles to idle and directing tower to raise the BAK-15 barrier. The IP began to max airbrake with approximately 5,200 feet of runway remaining. At 4,000 feet remaining, the aircraft drifted right, causing the right tire to blow as well. The RCP IP used a combination of braking, rudder, and nose wheel steering in an effort to maintain directional control. Despite these efforts, the aircraft departed the run way at 50 to 80 knots and struck a barrier stanchion (a 5.5 inch steel pole). The pole impacted the left side of the aircraft, causing substantial damage. The pole and nose gear sheared off, and the right main gear collapsed. Impact forces caused the FCP ejection seat to fire. The ejection was outside the envelope under high wind conditions, and the FCP IP was fatally injured. The RCP IP egressed without injury. Guidance for no-flap touch and go and tire wear during crosswind landings was nonexistent. The left tire blew for an unknown reason. Crosswinds, gross weight, pilot technique, and runway surface were possible contributing factors. The RCP IP performed an aggressive airbrake instead of prioritizing directional control. The aggressive airbrake allowed the aircraft to drift right, blowing the right tire. This mishap revealed several areas needing clarification regarding the go/no-go decisions. Additionally, the impact of crosswinds on directional control and tire stress needed to be addressed in more detail to prevent another such occurrence. Recommended additional guidance regarding tire wear during crosswind landings. Maintenance directives were changed to include additional guidance on T-38 tire inspections."	
128.	Explosives and Propellants	Check compliance with applicable Federal, State, and local requirements for all explosives and propellants in terms of use, storage, and disposal, in addition to verifying service (USAF) requirements are followed.	
129.	HAZMAT	Recommend the AIP incorporates adequate provisions on HAZMAT handling. Refer to Gamauf, *Handling Hangar Hazmat*, August 2012.	
130.	T-38 In-Flight Canopy Separation	Ensure the AIP addresses the proper maintenance and operating condition of all canopy locks. The USAF strengthened the canopy hook slots and fatigue-prone areas as part of its canopy area upgrades, and installation by Lear Siegler for the Dyncorp kits for this upgrade started in 1993. The T-38 canopy system is very lightweight and therefore somewhat fragile. Opening and closing the canopies is a manual operation normally requiring the use of both hands. Care should be taken during heavy winds when operating the canopies or if left in the open position in the elements. The canopy inspection program should include detailed checking of the latches and levers that interconnect to move and secure the canopy on a regular basis. FOD can cause canopy failures, inadvertent ejection seat activation, and damage to the engines after flight when the canopies are raised with the engines operating. Refer to *Cockpit FOD* above.	
131.	Canopy Seals	Test canopy seals for leaks (that is, use ground test connection).	
132.	Transparencies Problems	Ensure proper transparencies maintenance for safe operations. Monitor/inspect canopy for crazing every 10 hours of flight.	
133.	New Windshield	Ask whether the aircraft has been equipped with the new windscreen, which is more resistant to bird strikes. The aircraft is extremely vulnerable to bird strikes. Recommend the new USAF windshield installed in USAF T-38s as part of Pacer Classic II program be fitted. It has much better bird strike resistance and also eliminates windshield corrosion cracking issues.	

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134.	Emergency Canopy Jettison Mechanism	Verify the AIP includes testing the T-38 emergency canopy jettison mechanism. It must be functional and properly inspected per the applicable technical guidance. Note: The original canopy actuators were a major problem, and it was found that pilots could neither release nor jettison the canopy in an emergency situation. During the ejection sequence, but before the ejection seat ejects, a canopy jettison system removes the respective canopy. If the canopy jettison system does not operate, the canopy breakers on the parachute assembly break the canopy to let the ejection seat eject safely.	
135.	Brake System	Emphasize a detailed inspection of the brake assemblies, adhere to manufacturer's inspection guidelines and replacement times, and consider more conservative inspections. Recommend brake inspection at 20 to 30 landings. The following account of a T-38 brake-related accident not only emphasizes the maintenance aspect of the brake system, but also its operational impact: "The flight was the first sortie of a solo student out-and-back navigation mission. The SP lost aircraft control while braking during a landing at the non-Air Force out base. The left main landing gear departed the left side of the runway and struck an exposed concrete lighting pad, destroying the left main gear and substantially damaging the left wing and horizontal stabilizer. The aircraft came to rest on a taxiway at the departure end of the runway, and the SP egressed without injury. Maintenance personnel had not properly corrected a previously identified defective brake. The defect created a differential braking action, causing the aircraft to drift left as the SP applied the brakes. The SP failed to use the remaining brake, rudder, and/or nose wheel steering to remain on the runway. Although the flight manual did not specifically include guidance for directional control problems on landing, pilots were expected to use good judgment and common sense. In this case, the SP allowed the aircraft to drift versus using all available means to remain on the runway. Action Taken: Incorporated guidance for landing with a blown tire, locked brake, or directional control difficulty into TO IT-38A-l and added the following warning: If one brake system fails or failure is suspected, plan to land in the center of the runway. Stop the aircraft by using aerodynamic braking followed by a combination of wheel brake and nose wheel steering. Rudder pedals should be neutralized prior to engaging the nose wheel steering to prevent violent swerving and possible loss of directional control."	
136.	Hoses and Cables	Inspect and replace hoses and cables appropriately. Due to the age of all T-38 aircraft, and in many cases, poor storage history, it is essential to ensure thorough inspections of all hoses and cables (multiple systems) and replace them in accordance with USAF guidance and requirements.	
137.	Grounding	Verify adequate procedures are in place for grounding the aircraft. Static electricity could cause a fire or explosion, set off pyrotechnic cartridges, or result in any combination of the above. In grounding the aircraft, it is essential that all electrical tools are grounded, and industry-approved explosion-proof flashlights or other lighting sources be used.	
138.	TO 00-25-172	Use TO 00-25-172, Ground Servicing of Aircraft and Static Grounding/Bonding, dated August 2012, as the baseline for all servicing functions. This manual describes physical and/or chemical processes that may cause injury or death to personnel, or damage to equipment, if not properly followed. This safety summary includes general safety precautions and instructions that must be understood and applied during operation and maintenance to ensure personnel safety and protection of equipment.	
139.	Avionic Upgrade Program (AUP)	Ask whether the aircraft incorporates any of the USAF AUP for the T-38. If it does, ensure the AIP is adjusted accordingly. Note: Boeing was awarded a $45.6 million contract in 1996 and a $9.4 million contract in 2002 to design, develop, and implement the T-38 avionics upgrade for USAF aircraft under the USAF PMP. Israel Aircraft Industries was selected as a major subcontractor. The first T-38C aircraft upgraded as part of the AUP was delivered in July 2002, and more than 200 aircraft of the 500 contracted have been delivered. In February 2010, Advanced Simulation Technology supplied 39 Telestra 4 systems to Boeing for upgrading the T-38 avionics. The aircraft are being fitted with an avionics suite by Honeywell Military Avionics and are also being equipped with head-down displays, electronic displays, control panels, and instruments in both cockpits, and a HUD in the forward cockpit. The navigation system has been upgraded with the installation of an H-764G integrated GPS and inertial navigation system (INS), L-3 Avionics Systems RT-1634(V) tactical airborne navigation systems, radar altimeter, yaw-damping stability augmentation, an air data computer, and a traffic collision avoidance system (TCAS). Refer to *Antennas* below.	
140.	Angle of Attack (AOA) System	Ensure the AIP covers the adequate inspection and calibration of the AOA system and AOA indexer. In the T-38, the AOA is a critical instrument.	
141.	Antennas	Verify any original antennas are compatible with all installed electronics. In addition, verify the AIP includes the appropriate inspections of the antennas. Some new avionics may impose airspeed limitations. Over the years, many different antennas were installed in the T-38. For the basics on this issue, refer to Higdon, David. Aircraft as Antenna Farm. *Avionics,* Vol. 49, No. 9 (September 2012).	

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142.	Hard Landings and Over G Situations	Verify hard landing and over-G inspection programs are adopted. This is especially important when acrobatics are performed or when the aircraft is involved in military support missions outside the scope of its experimental certificate (that is, PAO), and in light of safety concerns with the wing and flight control surface cracks and delamination.	
143.	Nondestructive Inspection (NDI)	Ensure the AIP provides for all the required NDI or nondestructive testing under USAF guidance; TO 1T-38A-6; and TO 1T-38A-36, Nondestructive Inspection, USAF Series T-39A and T-38B Aircraft.	
144.	Parts Fabrication	Verify engineering (that is, designated engineering representative) data supports any part fabrication by maintenance personnel. Unfortunately, many modifications are made without adequate technical and validation data. AC 43.18, Fabrication of Aircraft Parts by Maintenance Personnel, may be used as guidance.	
145.	Wings and Tail Bolts and Bushings	Ask about inspections and magnafluxing of wings, and tail bolts and bushings. Recommend the AIP incorporate other commonly used and industry-accepted practices involving NDI if not addressed in the manufacturer's maintenance and inspection procedures. Note: The T-38 operational history of flight controls problems require detailed inspections of the wing attachment areas. Refer to TO 1T-38A-36.	
146.	Horizontal Stab Bearing Inspection and Lubrication	Ask if the AIP includes required inspections and maintenance of the horizontal stab bearings. Failure to properly lubricate/inspect the bearings or improper reinstallation could result in loss/failure of the bearings and in-flight loss of control.	
147.	Landing Gear Retraction Test and Related Maintenance	Verify the AIP provides for the regular landing gear retraction test and related maintenance tasks, including documentation, per USAF procedures and required equipment. The following T-38 accident analysis illustrates the importance of proper landing gear maintenance procedures: "The mission was an FCF for an engine change and work on the flight control rigging. The sortie proceeded normally until the alternate landing gear extension check. The right main landing gear indicated unsafe. The unsafe indication persisted after the pilot lowered the landing gear with the normal system. A chase ship visually confirmed the right main gear was 10 degrees shy of full extension and the side brace linkage had not reached the over-center position. The pilot made numerous attempts to lower the gear, to include applying G forces, yawing the aircraft, and shutting down the left engine to deplete hydraulic pressure. All were unsuccessful. In all, he made 17 attempts to lower the gear. As the fuel approached about 350 pounds, the crew entered the designated controlled bailout area and ejected successfully. The aircraft was destroyed upon impact. Maintenance technicians performed unscheduled maintenance on the landing gear, but did not comply with published T.O.s. Further, the technicians did not document their work in the aircraft forms or indicate what remained to be done. As a result, maintenance had not performed the operational landing gear extension and retraction check required by T.O.s. This is a common lesson. Failure to follow applicable TO guidance and document aircraft discrepancies in the AF T.O. IMT 781 aircraft maintenance log can lead to a mishap. This is not just for maintenance; it applies equally to aircrews. Action Take: (1) revised maintenance technical data to clarify those maintenance actions requiring subsequent gear retraction tests, (2) place emphasis on the importance of aircraft maintenance documentation and TO compliance."	
148.	Landing Gear Side-Brace Trunnion Failure	Verify the AIP provides for the inspection of the landing gear side-brace trunnion per the applicable USAF requirements. Replacement of this unit may be required per the latest USAF guidance and T.O.s. A T-38 accident analysis shows the failure of this component due to fatigue: "The mishap occurred at the conclusion of a two-ship formation training mission. The formation split for individual overhead approaches for full stop landings after a precision wing approach. A solo SP flew the mishap aircraft. In the final turn, the SP noticed that the right main landing gear indicated unsafe. A chase aircraft and the RSU confirmed the gear was partially extended. All attempts to fully extend the right main gear were unsuccessful, including shutting down the left engine and depleting utility hydraulic system pressure. The right engine flamed out from fuel starvation en route to the controlled bailout area. The SP ejected successfully, but the aircraft was destroyed. The side-brace trunnion of the right main landing gear failed due to fatigue, preventing the right main landing gear from extending fully. The SP needlessly placed himself and civilians on the ground at risk during the latter stages of the mishap. He failed to plan for the ejection and ran out of gas before completing the before-ejection checklist and before reaching the designated bailout area. Set a bingo fuel when working a malfunction, just like you set a bingo in the area. Once you reach bingo, transition to the next stage. Action Taken: established an inspection requirement to provide a more detailed ultrasonic inspection to identify cracks in the casting of the side brace trunnion."	

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149.	Main Landing Gear Strut	Verify the AIP provides for the proper inspection (including NDI) of the main landing gear struts. The following mishap narrative describes such a failure: "The mission was a single-ship accelerated copilot enrichment program instrument training sortie. The aircrew flew five instrument approaches including three touch-and-go landings. On the sixth approach, the aircrew felt extreme airframe buffet when they lowered the landing gear. The master caution light and left hydraulic pressure light illuminated. The left hydraulic pressure read between 100 and 200 pounds per square inch (psi), and the cockpit gear indicators showed the nose gear as safe and both main gear as unsafe. In addition, the aircrew noticed the airspeed indicators dropping to zero. They went missed approach with afterburner and accomplished the hydraulic failure emergency procedures checklist. The aircrew used the mirrors to look at the main gear and both appeared down. They flew an instrument approach to land, using the AOA as the primary airspeed reference. On touchdown, the aircrew felt as if the right main gear would not support the aircraft and executed a missed approach. They were now low on fuel so they proceeded to the controlled bailout area. (The hydraulic failure prevented a gear-up landing). Both crewmembers ejected successfully and were uninjured, but the aircraft was destroyed upon impact. Stress corrosion cracking developed in the area of the eyebolt attach point and forward door attach point of the outer cylinder of the right main landing gear strut. Technical data was inadequate and did not require a periodic T-38 main landing gear strut NDI. The pitot heat failed during flight because of circuit discontinuity, which was probably due to carbon deposits on the contacts in the pitot heat switch. As a result, the pitot tube accumulated ice, causing, and airspeed indicator system malfunction. The crew most likely lowered the gear in excess of 240 knots due to erroneous airspeed indications, overstressing the right main gear eyebolt attachment point. As a result of the excessive aerodynamic loads and the stress-corrosion cracking, the outer cylinder of the right main gear strut failed catastrophically. The left hydraulic system most likely developed a leak at a break in the line to the gear-actuating cylinder, depleting the system and preventing gear retraction. The right main gear would not support the weight of the aircraft for landing, so the crew made a good decision to go-around. Compound emergencies can be confusing and made even more so by their infrequent nature. Be sure to thoroughly analyze your indications before jumping to conclusions. If you cannot determine everything that is wrong with your aircraft, be conservative and plan for the worst case. Action Taken: developed periodic nondestructive inspections for main landing gear struts."	
150.	Landing Gear Alternate Release Cables	Verify the AIP addresses the inspection of the landing gear alternate release cable. Failures of this cable are well documented, as shown in the following accident narrative: "The mission was a weather check flight. The pilot lowered the landing gear handle during recovery as usual, but the left main and nose gear did not extend. Furthermore, the release cable failed during the alternate gear extension. The crew was unable to correct the problem so they flew to the controlled bailout area and ejected. The aircraft impacted the ground and was destroyed. Maintenance supervision and specialist training were inadequate to ensure thorough checks of the landing gear alternate release cable. This is T-38 landing gear alternate release cables had begun to fail 4 years prior to this mishap, but logistics managers failed to take appropriate action to correct the problem. Inadequate management and poorly conducted inspections resulted in a failure to detect the defective landing gear alternate release cable. The normal landing gear system probably failed due to a malfunction of the landing gear door sequencing switch or some other electrical component. The crew activated the landing gear alternate release system, but the cable failed and the gear did not extend. Maintenance failed to use the material deficiency reporting system correctly. When used properly, this system is a great tool and gives system managers an opportunity to correct inspection criteria or modify a defective system. This information system is a critical part of any successful mishap prevention program, but users must be disciplined and professional in reporting discrepancies. Action Taken: • Added the following caution to the appropriate T.O.s: *CAUTION* - Inspect cable within D-handle locknut. Failure to detect a defective alternate release cable within the D-handle locknut may result in cable failure and loss of emergency gear extension capability. • Added the requirement to inspect the landing gear alternate release cable within the locknut. • To the on-the-job training program, added the requirement to inspect the landing gear alternate release cable within the D-handle locknut. • Reevaluated landing gear alternate release D-handle assembly design to eliminate the cable's common failure point."	

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151.	Flap Actuator Rod End Failures	Verify the AIP addresses flap actuator rod end failures, per the most current USAF guidance, in terms of both inspections and replacement. This has been an issue with the aircraft, as shown by the following accident narrative: "The mishap aircraft was on a solo student training mission. Once back in the traffic pattern, the SP heard a loud bang when he extended the gear and flaps on inside downwind. Thinking it was a compressor stall, he scanned the engine instruments to identify the malfunction. When he looked back outside, the aircraft was nearly inverted. The SP decided to eject, but had some difficulty reaching the ejection handles. The aircraft completed roughly two and half revolutions before the SP finally ejected. He was uninjured, but the aircraft was destroyed upon impact. T-38 flap actuator rod end failures had been documented as early as 5 years before this mishap. The system manager noted an increase in failures 2 years before the mishap. Logistics managers started the process to design and procure an improved rod end, but they did not update the technical data concerning the old rod ends. Specific issues were: • The assigned time change interval did not provide an adequate safety margin to prevent fatigue failures; • The length of the periodic visual inspection interval prevented the timely detection of fatigue cracks; • TO guidance did not require NDI of the rod ends, and the prescribed visual inspection procedure was inadequate to detect cracks; The right flap actuator rod end developed a fatigue crack. The fatigue crack gradually grew, weakening the rod end. During the mishap sortie, the rod end failed as the flaps were lowered for landing. The SP delayed using aileron to counter the roll (or used insufficient aileron) and allowed the aircraft to enter a nose low attitude. Channelized attention was a contributing factor. The SP ejected as the aircraft rolled past 135 degrees of bank and in a 25- to 30-degree dive. Although flap rod ends had failed prior to this mishap, the seriousness of this malfunction was underestimated. No aircraft were lost in the previous instances due to pilot experience and the timing of the failures. (For instance, one failed in the final turn; but, luckily, it was the top wing. This caused the aircraft to roll *out* versus rolling *over*.) The SP's inexperience played a part in this mishap. He did not apply the first basic rule—maintain aircraft control. However, bad timing also played a part. Action Taken: • Incorporated critical action emergency procedures into TO IT-38A-1, emphasizing the different types of flap asymmetry and the need for immediate pilot action to recover the aircraft; • Reduced the time change interval on flap rod ends to minimize the possibility of fatigue failure; • Established adequate NDI procedures to detect fatigue cracks in flap rod ends; • Procured newly designed flap rod ends and expedited T-38 and F-5 retrofit." Note: The primary purpose of the flaps is to provide increased lift for takeoff and landing. The flaps should not be used in high AOA or aerobatic maneuvering. The flaps are electrically (DC) controlled by the flap lever switch, labeled "FLAPS," in the front cockpit. The flaps are operated by two AC electric motors and interconnected by a rotary flexible shaft. If one flap motor fails, both flaps are actuated through the rotary shaft. Flap extension time is much longer than normal with one motor failed.	
152.	Flaps H Drive and Limiters	Verify that the AIP incorporates the inspection of the flap H drive mechanism. Tom Stafford, one of NASA's astronauts who had flown the T-38 at Edwards recalls: "The T-38 had flaps that were electrically powered. The procedure on approach was to put the flap switch full down and leave it down. Not down, then back up to the neutral position. Every airplane that has flaps has a control mechanism liking the left and right flaps, so you don't have asymmetric movements. This linkage goes through a gearbox known as the H-drive. The flap controls have limiters to shut down once they've reached the proper position. When I had put the flaps down, the left flap stopped right where it should have, and the motor shut off. But the right flaps' limiter didn't work, so the motor kept pulling until finally it just pulled the mechanism in tow. The flap exploded up and the H-drive mechanism itself blew right out of the bottom of the fuselage. Had I crashed into the ground, the investigators might have said: 'Well, the dumb bastard got too slow and low on final approach…' Stafford, 2002.	
153.	Landing Gear Doors	Verify the AIP incorporates adequate inspection procedures for the landing gear doors, actuators, and sequencers. The dangers of in-flight gear door separation must be addressed, as shown by operational experience. Note: USAF's Tactical Air Command operated a squadron of T-38s in the Aggressor role from 1973 until replaced by the F-5E beginning in 1976. In the Aggressor role, the aircraft were subjected to more demanding maneuvering and "G" loads than experienced in the training environment. This caused additional airframe fatigue resulting in a series of accidents with T-38s based at Nellis Air Force Base and Clark Air Base in the Philippines. Three T-38s were lost at Nellis and two were lost in the Pacific before the cause of the accidents was discovered. The main landing gear doors would detach and strike the underside of the fuselage, puncturing the fuel cells and/or severing the control cables to the tail section. This resulted in uncontrolled roll and pitch movements and fires. The cause was identified after a Clark-based T-38 returned from a training mission with punctures in the fuselage and all but a few strands of a control cable severed. The aircraft was also missing a main gear door.	

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154.	T-38 Honeycomb Structures	Verify the AIP provides for the inspection and replacement of all bonded honeycomb structures per the applicable USAF T.O.s and related guidance, including— • TO 1T-38A-6, Aircraft Scheduled Inspection and Maintenance Requirements; • TO 1T-38A-3, Aircraft Structural Repair Instructions Manual; • TO 1T-38A-23, Corrosion Control, USAF Series T-38A and T-38B Aircraft; • TO 1T-38A-36, Nondestructive Inspection, USAF Series T-39A and T-38B Aircraft; and • T-38 Honeycomb Repair Analysis Report, Phase I (CDRF A003). The T-38 airframe uses bonded honeycomb in several flight-critical structural components (for example, wing leading edges, vertical stabilizer leading edges, flap and aileron edges, rudder, main landing gear doors, horizontal stabilizers, and wing tips). Procurement of spare parts is a lengthy and expensive process because few qualified manufacturers exist and part quality is highly dependent on strict manufacturing process control. Bonded honeycomb structure on the T-38 has aged and is experiencing an increasing number of failures (delamination and corrosion of the honeycomb core). Refer to *Fuselage Structural and Other Elements (1997 Study)* below.	
155.	Flight Control Balancing, Deflection, and Rigging	Verify flight controls were balanced per the USAF maintenance manual(s) after material replacement, repairs, and painting. Verify proper rigging and deflection. In several former military aircraft, damage to flight controls has been noticed when inadequate repairs have been performed. If there are no adequate records of the balancing of the flight controls, the airworthiness certificate should not be issued. The following T-38 accident illustrates this important issue: "The mission was flown as a two-ship formation training sortie with the mishap aircraft as Number 2. Takeoff, departure, and initial area work (to include extended trail) were uneventful. About 30 minutes into the profile, the lead aircraft initiated a right-turning rejoin at approximately 10,000 feet AGL. The IP in the lead aircraft observed Number 2 approach to approximately 500 feet, enter a rapid tight barrel roll to the left, and disappear from sight. During the maneuver, Number 2 made a garbled radio transmission and the only discernible word was 'break.' Lead was not able to reestablish visual or radio contact with his wingman. The mishap aircraft impacted the ground extremely nose low at high velocity. Neither crewmember ejected, and both were fatally injured. At an unknown time, maintenance personnel failed to install the cotter pin on the rod end 'V' and valve push rod connecting bolt (left aileron). Maintenance supervisors failed to detect the problem during subsequent inspections. During flight, the unsecured nut backed off, allowing the rod end 'V' to become disconnected from the valve push rod. The left aileron moved to an un-commanded position, resulting in an uncontrollable left roll. Complacency and failure to follow TO guidance resulted in the loss of an aircraft and crew. Maintainers and supervisors must remain focused and alert for maintenance errors or technical data deficiencies. Action Taken: Accomplished a one-time inspection of all T-38 and F-5 aircraft aileron-actuating mechanisms. Where feasible, installed self-locking castellated nuts in critical flight control areas of T-38 and F-5 aircraft. Revised task orientation training (TOT) for personnel conducting periodic maintenance to include a familiarization course in primary flight control inspections. Improved physical inspection (PE) work cards by adding a picture of the aileron mechanism and the following warning: Failure to install cotter pins and safety wire can cause loss of aircraft and possible fatal injury to aircrews." Also refer to *Aileron Failure and Proper Inspections* below.	

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156.	Release of Aircraft Following Flight Control Malfunctions (AFI 21-101/AETC Sup 1, *Aerospace Equipment Maintenance Management)*	Ensure the AIP provides for proper and updated USAF procedures to release the aircraft following flight control malfunctions. Although incorporating operator (pilot) error, this recent T-38 accident illustrates the importance of adequate maintenance procedures regarding the flight control system: "The mishap sortie was a pre-solo contact sortie. The SP performed the takeoff and lifted off at approximately 155 knots. The SP was using stick only to control the aircraft and had his feet flat on the floor. The aircraft rolled right immediately after takeoff, and the SP overcorrected with left aileron causing the aircraft to roll into approximately 60 degrees of left bank. The SP told the IP something was wrong. The IP stepped on the rudder to counter the roll, but did not communicate transfer of control to the SP. The SP continued to fight the roll with ailerons. He did not know the IP was making rudder inputs because his feet were still on the floor. The combined and uncoordinated efforts of both aircrew members resulted in a rolling pilot induced oscillation (PIO). As the aircraft rolled back and forth reaching 90 degrees of bank in both directions, the IP commanded bailout. The crew ejected successfully just prior to the aircraft striking the ground. The aircraft departed the runway, skidded through the grass, and came to rest in the center of the adjacent parallel runway. Maintenance Factor: The aircraft had previously been written up for an un-commanded rolling motion. Maintenance determined the stability augmenter caused the roll, but they did not consult with Operations before releasing the aircraft for flight. If they had, Operations would have known that the type of rolling motion described in the original AF T.O. IMT 781, *ARMS Aircrew Mission Flight Data Document,* write-up would not have come from a stability augmenter malfunction and would have ordered a functional check flight (FCF) prior to release. The roll was more likely caused by elongated holes in one of the wingtips where the wingtip attached to the main wing, allowing the wingtip to shift out of position. Operator Factor: The SP over-controlled the aircraft due to inexperience. The SP's attempts to control the aircraft were probably aggravated by the un-commanded rolling tendencies of the aircraft. Supervisory Factor: The IP did not take control of the aircraft with a 'positive exchange of aircraft control.' This resulted in the IP and SP unknowingly fighting each other for control of the aircraft. Although the aircraft was controllable, the crew thought they were out of control and ejected. Operator Factor: The IP was complacent and not mentally prepared to take control of the aircraft. This led to a 'reactive' response as opposed to a deliberate and properly executed transfer of aircraft control. Lesson Learned. Although both the IP and SP survived, this was another reminder complacency can kill. You need to be on your game flying high performance aircraft, particularly during critical phases of flight. The IP was complacent and not mentally prepared to take control of the aircraft. Improper execution of a basic task like transfer of aircraft control cost an airplane and nearly the crew. A pilot tends to fall prey to complacency around 400 to 800 hours. (This IP had approximately 450 hours in the T-38). In addition, the SP's habit of flying with his feet on the floor prevented him from identifying the IP's rudder inputs as one source of the aircraft's rolling motion. Action Taken: Requested a change to AFI 21-101/AETC Sup 1, *Aerospace Equipment Maintenance Management,* to require operations coordination for release of aircraft following impoundment for flight control malfunctions. Requested evaluation of the failure detection and fault accommodation capability of the stability augmenter system. Recommended changing AFI 11-290/AETC Sup 1, *Cockpit/Crew Resource Management Training Program,* to require IP complacency and proper transfer of aircraft control during critical phases of flight as an annual briefing topic."	

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157.	Flap and Slab Interconnect Cable	Ensure the AIP provides for proper and updated USAF procedures for the inspection of the flap and slab interconnect cable. The following T-38 accident was caused by improper inspection procedures and highlights the need for adequate maintenance procedures: "The mission was the SP's initial solo formation flight, and he was assigned to lead the formation takeoff. During takeoff roll, the mishap aircraft appeared to over rotate and pitch up when breaking ground. The wingman moved abeam and then passed the mishap aircraft, losing sight. The mishap SP regained control of the aircraft and notified the wingman of a pitch control problem. He regained the lead and continued the departure. The SOF suggested the flight burn down fuel and come back for a straight-in approach. The SOF also suggested the SP do a controllability check with landing gear up and 60 percent flaps. The SP lowered the flaps at FL 190. The aircraft began to pitch up and then rolled into a steep left bank. The wingman initiated a breakout, losing sight of the mishap aircraft. When the wingman reacquired the mishap aircraft, it was inverted, rotating, and descending. The SP ejected successfully, but the aircraft was destroyed upon impact. The flap and slab interconnect cable was not connected to the horizontal tail's operating mechanism during installation of the boat tail the night before the mishap sortie. Additionally, the required post-maintenance inspections failed to identify the discrepancy. The SP and crew chief did not check for proper movement of the flaps and slabs IAW appropriate checklists. The mishap SP failed to properly analyze the situation and provide an accurate and complete description of the conditions to his wingman IP or the SOF. The SP extended the speed brakes to expedite fuel burn, which compressed the time available for analysis. TO 1T-38A-l does not adequately address the characteristics of flap and slab inter-connect failure. Additionally, the structural damage or controllability check procedure contained misleading guidance if applied to suspected flap and slab interconnect problems. Neither the wingman IP or the SOF adequately analyzed the malfunction. This led the SOF to suggest lowering the flaps during the controllability check. This mishap resulted from a series of errors, similar to links in a chain. Breaking one link or eliminating even one error would have prevented the mishap. The first link in the chain involved maintenance errors. Maintenance personnel failed to connect the horizontal tail's operating mechanism during installation of the boat tail, most likely due to complacency. This was their third boat tail installation on shift, and they may have rushed the job to get done before shift change. In addition, the quality control augmenter failed to use the two-man challenge and response checklist. Instead, he or she performed the checklist without assistance and did not ensure all checks were accomplished. The second link broke when the SP failed to visually confirm slab movement as directed in the before-taxi checklist. He depended totally on the crew chief to ensure correct positioning of the slab, but the crew chief did not confirm movement either. The SP failed to properly analyze the malfunction and eventually lost control of the aircraft. The third and final link in the chain occurred when the SOF and wingman IP failed to thoroughly analyze the malfunction. The SOF may have been overly concerned with the SP landing with no flaps due to inadequacies in TO 1T-38A-1 that lead the SOF to suggest lowering the flaps in the controllability check. Bottom line: Comply with the checklist, visually confirm that your flight controls move correctly, and do not rely exclusively on ground personnel for confirmation. Action Taken: • Expanded TO 1T-38A-l guidance regarding the flap-horizontal tail inter-connect system; • Changed TO 1T-38A-l to clarify the objective of and the guidance for a controllability check; • Changed maintenance T.O.s to require door #47 be sealed by the quality assurance team after completion of the challenge-and-response inspection following boat tail installation; • Changed maintenance T.O.s to require an operational check of the flap-horizontal tail interconnect system following boat tail installation; During the controllability check, the SP failed to maintain aircraft control. The aircraft probably entered a stall as the flaps extended. Delayed pilot reaction or incorrect flight control inputs to recover the aircraft may have led to the loss of control."	

#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
158.	Horizontal Tail Control Mechanism	Ensure the AIP provides for proper and updated USAF procedures for the inspection of the horizontal tail control mechanism. The following T-38 accident illustrates this: "The mission was a solo FCF. During a 4 G turn at flight level (FL) 210, the pilot felt something 'let go' in the flight control system. He tried to gain control of the aircraft for approximately 5 minutes by lowering the gear and flaps, but the aircraft remained in a nose low, left hand spiral. The pilot told the SOF and radar approach control that he planned to eject, and he bailed out approaching 6,000 feet AGL. He received minor injuries during the ejection due to improper body position and again during the parachute-landing fall when he impacted some trees. (He did not perform the four-line jettison). The aircraft was destroyed upon impact. A design deficiency in the T-38 flight control system allowed a single point failure of the cable assembly of the horizontal tail control mechanism. The 'A' cable in the horizontal tail control mechanism separated due to material failure and/or improper maintenance. Although investigators could not determine exactly why the 'A' cable failed, the mishap highlighted a design deficiency that allowed a single point of failure. (A failure of one of four cables resulted in the loss of an aircraft). Pilots must always mentally rehearse ejection procedures when practicing emergencies and make sure to consider the proper body position and post-ejection actions. Action Taken: • Recommended engineers evaluate feasibility of redesigning the horizontal tail control mechanism (for example, add redundancy) to prevent a single point failure; • Recommended replacing the horizontal tail control mechanism cables of all T-38s during the PE and every fourth PE thereafter. Requested inspection of the horizontal tail control mechanism cables during the challenge and response checklist for panel #47." Also refer to *Horizontal Stabilator Actuator Servo Valve Control Rod Assembly* below.	
159.	Stability Augmenter System (SAS)	Ensure the AIP provides for proper and updated USAF procedures for the inspection of the SAS. This system has a history of malfunctioning. The following T-38 accident account describes such a malfunction: "The mission was a single-ship, navigation flight evaluation. After 40 minutes of uneventful flight, the aircrew declared an emergency for a flight control problem. The crew started a descent and proceeded to an emergency airfield. During the descent, the IP transmitted the crew's intention to eject. Both crewmembers ejected successfully and were uninjured, but the aircraft was destroyed upon impact. An undetermined component of the stability augmenter system (SAS) malfunctioned during straight-and-level, un-accelerated flight. The aircraft suddenly yawed to the left and then began rolling left. After assuming control of the aircraft, the IP failed to fully evaluate the flight control abnormality and incorrectly assumed the left rolling tendency was caused by an aileron control malfunction. The IP may have jumped to this conclusion based on his knowledge of a previous T-38 aircraft mishap caused by an aileron disconnect. During the descent, the SP improperly interpreted a shake of the control stick as a nonverbal signal transferring aircraft control to him, even though the intercom was working perfectly. The SP attempted to assume control of the aircraft, unknowingly applying control inputs in opposition to the IP. The IP did not recognize the conflicting control stick inputs as coming from the SP and assumed the supposed aileron control malfunction had degraded enough to prevent a safe landing. The IP directed ejection, and both crewmembers ejected successfully. Because the IP had recently lost a friend in a mishap caused by an aileron malfunction, he may have had a perceptual set that led him to misinterpret this malfunction as aileron induced. A stability augmenter malfunction could easily be misinterpreted as an aileron malfunction. Therefore, if practical, get a chase ship or just look outside at the wings to determine if the ailerons are responding appropriately. That is, thoroughly analyze the indications when time and conditions permit. In addition, improper transfer of aircraft control has caused several aircraft losses so be sure to discuss verbal and nonverbal transfers in detail." Also refer to *Release of Aircraft Following Flight Control Malfunctions (AFI 21-101/AETC Sup 1, Aerospace Equipment Maintenance Management)* above.	

#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
160.	Horizontal Stabilator Actuator Servo Valve Control Rod Assembly	Ensure the AIP provides for proper and updated USAF procedures for the inspection of the horizontal stabilator actuator servo valve control rod assembly. As with many other flight control issues with the T-38, the accident narrative below explains: "The mishap sortie was a two-ship formation check ride. During the G warm-up maneuver, the mishap aircraft executed a smooth un-commanded pitch-up. The IP initiated a nose high recovery, but the aircraft entered a left turn and would not respond to control inputs. The crew ejected successfully, but the aircraft was destroyed upon impact. The Air Force accepted the T-38 flight control system design, even though the design allowed for multiple single point failures in each of its three axis. The design of the horizontal stabilator actuator servo valve control rod assembly is insufficient and does not prevent fatigue failures during the life of the assembly. The T-38 system manager failed to implement inspection criteria or a time change interval for the horizontal stabilator actuator servo valve control rod assembly despite a report many years earlier that highlighted the T-38's susceptibility to catastrophic single point failures in the flight control system. By default, the rod assembly became a fly-to-fail part with no back-up system. During this mishap, the ends of the stabilator actuator servo valve control rod failed due to undetected, high cycle fatigue. Lessons learned from previous incidents and accidents went unheeded, resulting in an additional loss of aircraft and near loss of life. The lessons learned from aircraft mishaps are often paid for in blood, so we must learn from the experience of others. Take those lessons to heart so you do not have to pay the price yourself. Action Taken: • Conducted a one-time inspection of all T-38 servo valve rod ends; • Recommended establishing service life criteria for the entire horizontal stabilator actuator servo valve control rod assembly. Evaluated procedures and time change intervals for the rod assembly of the horizontal stabilator actuator servo valve control. These recommendations were for all single-point failure locations; • Recommended expanding existing Air Force directives regarding requirements for service life extension programs to include aging aircraft issues not related to primary structural elements and components."	
161.	Incorrect Rudder Installation, Adjustment, and Maintenance	Ensure the AIP provides for proper rudder installation, adjustment, and inspection. A recent fatal T-38 accident at the USAF flight test center was due to a failure of the rudder actuator system, causing a full deflection rudder at high speed. That 2009 accident is described as follows: "A T-38A aircraft assigned to the 412th Test Wing impacted the ground 12 miles north of Edwards Air Force Base (AFB), California, while participating in a United States Air Force Test Pilot School (USAF TPS) training mission. The mishap navigator (MN) ejected from the aircraft and sustained serious injuries. The mishap pilot (MP) did not initiate ejection and died upon impact with the ground. The mishap aircraft (MA) was completely destroyed upon impact. The AIB president found clear and convincing evidence that the cause of this mishap was the failure of the rudder operating mechanism, causing the rudder to deflect 30 degrees left. This hardover rudder induced an uncontrollable yaw and a resulting roll, causing the aircraft to depart controlled flight. This condition is unrecoverable in the T-38. The AIB president found substantial evidence to conclude that due to a maintenance error, one of the seven bolts securing the rudder operating mechanism was improperly secured. The unsecured bolt worked its way free over an unknown period of time, eventually backing out of its location sufficiently to allow the two critical components to separate, thus disconnecting the flight controls from the rudder actuators. The pilot's properly-executed zero-to-negative-g input was the final but not casual condition that allowed the bolt to finally work free, disconnecting the rudder's controls. The pilot-induced pitch down, followed immediately by a non-pilot-induced rapid yaw and roll, incapacitated the MP, from which he never recovered. Improper maintenance practices, including training, documentation, and oversight of maintenance personnel, were factors in allowing this mishap." Also refer to http://www.torch.aetc.af.mil/news/story.asp?id=123180539.	
162.	New Aileron Levers	Ask whether the aircraft has the new USAF aileron levers installed. If not, recommend it be done, and if done, ensure the AIP is adjusted accordingly. This is a critical safety-of-flight issue. The levers, which control moveable flaps on the T-38's wings, are being machined by the shop from a solid block of aluminum. The five-step process takes about a week from the initial milling to the final delivery to units in the field. The workload resulted from an April 2008 T-38 crash at Columbus Air Force Base in Mississippi, which killed two pilots and destroyed the airplane. An accident investigation board determined the cause of the mishap was a mechanical failure of the right aileron, which failed in the full down position before takeoff. The aircraft's original levers were made from a forged series of aluminum alloy, heated metal pounded into shape. Refer to *Work Continues at Hill AFB to Replace T-38 Aileron Levers* at http://www.afsc.af.mil/shared/media/document/AFD-071016-077.pdf.	
163.	Aileron Servo-Valve Spool	Ensure the AIP provides for the inspection of the aileron servo-valve spool. This component has been linked to accidents. A T-38 accident investigation found that "the manufacturer's quality assurance procedures were inadequate. The manufacturer failed to ensure the left aileron servo-valve assembly was manufactured to design specifications. As a result, the left aileron servo-valve spool was not properly aged (USAF term) and became bowed during subsequent operation. The bowed spool caused binding and introduced a downward force on the assembly, driving the left aileron to the full down position and rendering the aircraft uncontrollable. Action Taken: Reviewed quality control procedures on aileron servo valves and spools to ensure design specifications were met."	

#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
164.	Aileron Failure and Proper Inspections	Verify the AIP and related procedures, including daily, preflight, and post-flight checks, include the inspection of the ailerons. A noteworthy example was the aileron jam that caused the October 1967 crash that killed astronaut Clifton Williams. More recently, the investigation of another USAF T-38 crash noted: "The flight was scheduled as a dual contact training mission. The IP performed the takeoff in accordance with (IAW) the mission brief. The left wing dropped immediately after liftoff as if the aircraft had encountered mild wake turbulence or a strong crosswind. The IP applied right aileron and a slight amount of right rudder to correct the bank. As the wings leveled, the IP relaxed the aileron and rudder pressure and the aircraft immediately rolled sharply left to approximately 45 degrees of bank. The IP immediately applied right aileron and right rudder, but the aircraft did not respond as anticipated. He continued aileron and rudder application until he had full right aileron and full right rudder. The aircraft was low to the ground and had veered left away from the runway surface. It was in an extreme skid due to the full right rudder application, but started to roll out of the bank. The IP relaxed some of the control pressure as the aircraft approached wings level; but when he did, the aircraft rolled sharply left again to approximately 90 degrees of bank. He applied full right aileron and full right rudder one more time, managed to bring the aircraft back to a near wings-level attitude, and commanded ejection. The aircraft was now around 300 feet AGL and 220 knots. The SP ejected immediately and was uninjured. As the IP relaxed the control stick to initiate his ejection, the aircraft rolled left to approximately 70 to 90 degrees of bank. Despite the low altitude and aircraft attitude, the IP also ejected successfully. The aircraft continued its descent and impacted the ground in 80 to 90 degrees of left bank and 45 degrees nose low. The aircraft was destroyed upon impact. Maintenance Factor: An unknown person failed to install the cotter pin that secures the nut on the connecting bolt and valve push rod for the right aileron. The nut backed off, and the right aileron moved to a near full down position, resulting in a loss of aircraft control. Supervisory Factor: Supervision failed to conduct proper post-maintenance inspections. Lesson Learned: Flight control malfunctions at low altitude are extraordinarily challenging, requiring timely analysis, and decision-making while threatening to saturate your task management ability. You have little time to determine the aircraft's controllability before exceeding the ejection envelope. Consider your ejection criteria before you release the brakes." Note: The AIP should also address the aileron boost tab systems.	
165.	USAF Pacer Classic Programs (General)	Ask whether the aircraft incorporates any of the USAF Pacer Classic programs for the T-38. If Pacer Classic changes are incorporated, ensure the AIP is adjusted accordingly. If not, recommend several Pacer Classic improvements be considered. Note: As part of the USAF Pacer Classic program, initiated in 1984, the structural integrity work on the T-38 includes replacement of the ejection seats, longerons, landing gear and brakes, flight controls, and an impact-resistant canopy. In May 2011, Pacer Classic III was proposed to enhance the service life of T-38 aircraft up to 2020. Note: Pacer Classic I concluded in 1992, and Pacer Classic II started in 1993. Pacer Classic II is the last iteration. A total of 125 aircraft were chosen in this phase. The USAF initiated a T-38 wing life improvement program in 1997, and Northrop Grumman was awarded a $3.2 million contract in 2001 to develop a newly designed wing incorporating fatigue-resistant aluminum alloys. Northrop Grumman has developed the new wing to augment the aircraft's service span up to 2020.	
166.	Wing Inspections and Life Limit	Ensure that at a minimum, and in addition to the required inspections, the AIP provides for the replacement of the wing at the specified life limit using USAF guidance. Operations past the life limit of the wing are prohibited. Original wings are no longer in use by the USAF because of failures. Note: The first major T-38 structural modification was a new wing with thicker skin. This followed several wing failures in 1978, and was completed in 1986. The wing issue was so serious that another wing upgrade and installation program was started in 2001. Refer to *Wing Failure (Cracks) (1997 Study)* below. Note: Structural issues with the T-38 were a concern as early as 1970. As a result, the USAF commissioned an investigative study. Refer to Clay, Larry E. T-*38 STRUCTURAL FLIGHT LOADS DATA FOR JUNE 1970 THROUGH DECEMBER 1971.* AD-758 891, Technology, Incorporated Prepared for: Aeronautical Systems Division, April 1973.	
167.	Dorsal Longeron	Ensure the AIP provides for the inspection of the dorsal longeron per the applicable USAF inspection criteria. Recommend the Longeron reinforcement accomplished by the USAF also be considered. Structural concerns in the early 1980s about fatigue life of T-38 dorsal longerons (the structural backbone of the airframe from the rear cockpit to the tail) led to fuselage modifications beginning in 1983. A 14-foot contoured steel longeron was placed next to the original aluminum structure to prevent stress-induced failure. This was done as part of the Pacer Classic II program. Note: Proper treatment is required to address the aluminum/steel interaction.	
168.	Fuselage Cockpit Longerons	Ensure the AIP provides for the inspection of the fuselage cockpit longerons. Refer to *Fuselage Structural and Other Elements (1997 Study)* below.	
169.	Bulkhead at Fuselage Station 325	Ensure the AIP provides for the inspection and replacement of the bulkhead at fuselage station 325 per the latest applicable USAF guidance and T.O.s. This was done for safety reasons, and the bulkhead was replaced because it had experienced stress corrosion cracking. The new aluminum bulkhead has improved damage tolerance properties. Refer to *Fuselage Structural and Other Elements (1997 Study)* below.	

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170.	Other Fuselage Stations	Ensure the AIP provides for the inspection of the bulkhead at fuselage stations 362, as well as the formers at fuselage stations 332, 487, and 508. This needs to be accomplished per the latest applicable USAF guidance and T.O.s. Refer to *Fuselage Structural and Other Elements (1997 Study)* below.	
171.	Cracking of the Forward Splice at Fuselage Station 284	Ensure the AIP provides for the inspection (for cracking) of the forward splice at fuselage station 284 (splice joint aft of the rear cockpit) per the latest applicable USAF guidance and T.O.s. This work was part of the Cockpit Enclosure Modifications (CEM) effort. Refer to *Fuselage Structural and Other Elements (1997 Study)* and DERP below.	
172.	Magnesium Flight Controls Components	Ensure the AIP provides for the inspection, repair, and replacement of magnesium flight controls components per the latest applicable USAF guidance and T.O.s. Under the USAF replacement program, 31 cracking magnesium alloy flight control components were replaced with aluminum fittings. Refer to *Fuselage Structural and Other Elements (1997 Study)* below.	
173.	Upper Deck Repairs	Ensure the AIP provides for the inspection and repair of the upper deck per the latest applicable USAF guidance and T.O.s. This effort, as part of the CEM effort, focused on replacing cracking components to prevent loss of pressurization. Refer to *Pressurization Vessel and Environmental Control* above.	
174.	Forward Nacelles	Ensure the AIP provides for the inspection and repairs of the forward nacelles skins per the latest applicable USAF guidance and T.O.s. These areas are prone with cracking issues.	
175.	Lower Wing Skin Fastener Holes	Ensure the AIP provides for the inspection, repair, and replacement of wing skin fastener holes per the latest applicable USAF guidance and T.O.s. There are documented issues in these areas, including cracking. Refer to *Wing Failure (Cracks) (1997 Study) (Part II)* below.	
176.	Depot Economy Repair Program (DERP)	Ensure the AIP incorporates the issues addressed under the USAF's DERP. DERP activities included speed-brake repairs, boat-tail rework, repair of the center and aft fuel cell floors, reseal of the fuel cell cavity, and inspection of the spice joint aft of the rear cockpit at fuselage station 284.	
177.	Wing Spar Reinforcement	Ensure the AIP provides for the inspection (and consider the reinforcement) of the wing spar, referred to as the "66 percent wing spar reinforcement strap modifications." This must done per the latest applicable USAF guidance and T.O.s.	
178.	New Wing	Recommend installing a new complete wing if the existing wing is an original T-38 wing. The safety benefits of such a modification are significant. In addition, the new wing has double the life of the original wing. Refer to *Wing Failure (Cracks) (1997 Study) (Part I)* below.	

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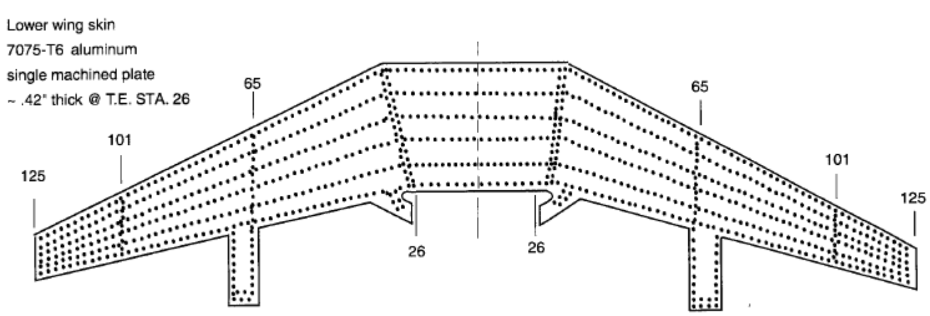
179.	Wing Failure (Cracks) (1997 Study) (Part I)	Ensure the AIP provides for the inspection and repair/replacement of wings/components, possibly at a higher frequency than originally called for in the applicable TO if the aircraft is an unmodified T-38A. The following in-flight failure of a T-38 wing describes the issue: "The mission was an advanced contact student training sortie. Takeoff and departure to the working area were uneventful. After completing several aerobatic maneuvers, the aircrew initiated a loop at 500 knots and 5.5 Gs. The left wing failed, and the aircraft immediately departed controlled flight. Both crewmembers ejected successfully, and the aircraft was destroyed upon impact. The mishap wing was an older, thin-skin design. The lower left wing developed a fatigue crack at a 'jo' bolt fastener, which ultimately failed under tension during the 5.5 G loop. NDI ultrasonic rotoscan procedures previously failed to identify the crack. The thin-skin wings were susceptible to fatigue cracks, and all were being replaced with thicker skin wings. Although the rotoscan procedure was demanding and difficult to perform, it was the only available procedure to detect the early stages of wing skin cracks. Action Taken: Replaced all thin-skin wings with thicker-skin wings, and re-evaluate rotoscan procedures and review the development of advanced NDI equipment. A fixture was being developed to support the rotoscan unit, which will reduce operator fatigue. A new digital ultrasonic system with a video recording capability will improve NDI inspections and provide a permanent record of inspection results." A detailed 1997 study into the T-38 aging issues noted "the T-38 is of particular concern because of its single plank lower wing skin, its very small critical crack sizes (that is, 0.20 to 0.40 in.), and the age of the aircraft in terms of both calendar years and flight hours. Wing failure and aircraft losses occurred during the 1970s when these aircraft were put into severe roles. For example, the lower wing skin was machined from a single plate of 7075-T6 aluminum, which was 0.42 in. thick at the root trailing edge (that is, wing station 26; see Figure A-10). In 1970 there was a failure of this lower wing skin on an F-5 (high-level of commonality with the T-38, including some structural components) stationed at Williams AFB in Chandler, Arizona. It was caused by a fatigue crack, which originated at the trailing-edge radius at wing station 26 and grew to a critical size of about 0.20 in. at the time of failure. As a result of this failure, the lower wing skins on the F-5s were increased in thickness so as to lower the stresses by about 20 percent, but, because of their less severe use in the Air Training Command (ATC), no change was made to the wing skins on the T-38s. However, by the mid-1970s there was increasing evidence of potential structural problems with the T-38 that led the Air Force to initiate a detailed DADTA. Some T-38s had been moved from the relatively mild use of the ATC to the Tactical Air Command's more severe lead-infighter (LIF) and dissimilar air combat training (DACT) use. Also, because of the fuel shortages of the early 1970s, the F-4s had been removed as the Thunderbird demonstration team's aircraft and replaced by the more fuel-efficient T-38s. Adding to the concern was the fact that, in 1975, the wing on a T-38 at Holloman AFB was found to be cracked in the same area as the aircraft in the 1970 accident at Williams AFB, but fortunately the crack ran into another fastener hole and was temporarily arrested. Also, there had been two fatigue test failures originating in the same area. During the time of the DADTA, an aircraft was lost at Randolph AFB due to a wing failure that, again, originated in the same area. A short time later, an aircraft assigned to DACT use was lost due a wing failure. In addition to the serious trailing-edge area already noted, the DADTA identified 16 more potentially critical areas in the wing, 15 in the fuselage, and 3 in the empennage. Also, improved finite element stress analyses were performed on the entire aircraft, and stress spectra were developed for the critical areas based on measured LEF, DACT, and Thunderbird use and the improved analyses. Tear-down inspections were performed on 11 wings with about 4,000 to 6,000 hours of ATC plus 500 to 700 hours of LIF, DACT, or Thunderbird use and on 3 wings that had been only in ATC use. These inspections indicated that the wings that had been exposed to the severe use had from 12 to 90 small fatigue cracks in the high-stressed fastener holes in the aft in-board portion of the wing, whereas those that had only ATC use were essentially crack free."  FIGURE A-10 Original lower wing skin design for the T-38 aircraft.	

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180.	Wing Failure (Cracks) (1997 Study) (Part II)	"The damage tolerance analyses indicated that the critical crack sizes in the aft in-board areas of the wing were very small (for example, less than 0.10 in. for low fracture toughness 7075-T6 aluminum), making the task of protecting structural safety by inspection nearly impossible. It was apparent that the long-term solution required replacing the lower wing skin with a thicker lower-stressed skin made from a tougher material. Also, it was recommended that the holes in the higher stressed areas of the wing be cold worked. The near-term actions included (1) culling out all wings that had low fracture toughness material using a technique involving measuring the chemical composition of the material and correlating it with a previously established relationship between toughness and chemical composition and (2) using a trained team of NDE specialists to inspect the specific critical locations of the remaining wings using an ultrasonic technique at very frequent intervals. Since the DADTA and the resulting recovery program in the late 1970s, the lower wing skins have been replaced with thicker skins made from 7075-T73 aluminum, the fastener holes and drain holes in high-stressed areas have been cold worked, and additional full-scale fatigue testing has been performed. Also, the T-38s have been replaced by F-16s in the Thunderbird demonstration team, and the Air Force no longer uses the T-38 in DACT use and has replaced LIF use with IFF use. However, the IFF use is still apparently quite severe. Based on the briefing the committee received on the T-38 structural status in November 1996, the aircraft continue to have more structural problems, and further design changes and full-scale fatigue testing are planned." Specific fatigue cracking problems were identified in the current wings and fuselage of the T-38: Lower surface of the wing: <u>Wing Main Landing Gear Door Land Radius</u> - Cracking into main skin not repairable; - Modification of land plus special inspection required; and - Future design change. <u>Lower Wing Skin Fastener Holes</u> - Small critical crack sizes (0.2-0.4 in.); - Over sizing and cold working required; and - Future design change. <u>Wing Skin Access Panel Holes</u> - D panel; aileron access panel; - Cracking into main skin not repairable; - Stop drill/special inspection (temporary); - Boron/epoxy doubler (temporary); and - Force mate bushings under study. <u>Milled Pockets on the Lower Wing Skin</u> - Cracking in milled radius; - Not repairable; - Composite reinforcement under study; and - Future design change." Note: A major USAF modernization program included replacement of all magnesium flight control attachment points and installation of new wings due to cracking. Also refer to *USAF Pacer Classic Programs (General)* and *Aileron Failure and Proper Inspections* above. Note: As documented in *Aging of U.S. Air Force Aircraft* (Publication NMAB-488-2, NATIONAL ACADEMY PRESS, Washington, D.C., 1997), the USAF requested the National Research Council identify R&D needs and opportunities to support the continued operation of its aging aircraft, including the T-38. Specifically, this study focused on aging aircraft structures and materials and had the major objectives of (1) developing an overall strategy addressing the USAF's aging aircraft needs, and (2) recommending and prioritizing specific technology opportunities in the areas of fatigue, corrosion fatigue, and stress corrosion cracking corrosion prevention and mitigation; NDI maintenance and repair; and failure analysis and life prediction methodologies. To accomplish this study, the committee conducted working sessions to identify current aging aircraft problems and technology needs, review ongoing and planned aging aircraft R&D efforts by the USAF, and review related research at other government agencies, within industry, and in the academic research community.	

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181.	Fuselage Structural and Other Elements (1997 Study)	Ensure the AIP provides for the inspection and repair/replacement of the fuselage, possibly at a higher frequency than originally called for in the applicable TO if the aircraft is an unmodified T-38A. The following was extracted from a 1997 study on the aging of the T-38. Specific fatigue cracking problems were identified in the current fuselage of the T-38: <u>Fuselage Upper Cockpit Longerons</u> - Hookslot cracking; - Small critical crack sizes; - Low inspection intervals; - Material change/redesign; - Force-wide modification in progress; - Force-wide modification of bulkhead at fuselage station 325; and - Inspect and repair remaining changes. <u>Fuselage Cockpit Longerons</u> - Upper and lower longerons; - 7075-T6 aluminum; - Cracking of the forward splice at fuselage station 284; - Inspect and repair (interim); - Material change/redesign; - Force-wide modification of upper longerons; and - Force-wide inspection/repair of lower longerons. <u>Fuselage Forgings</u> - Bulkheads at fuselage stations 325 and 362; formers at fuselage stations 332, 487, and 508; and - Temporary repairs. <u>Landing Gear Strut Door</u> - Core corrosion attributable to water intrusion; - Super plastic formed/diffusion-bonded titanium; and - Current preferred spare. Note: Also refer to *Main Landing Gear Strut* above. The following honeycomb deterioration problems were also noted: <u>Horizontal Stabilizer</u> - Core corrosion attributable to water intrusion; and - Improved bonding being implemented. Note: Also refer to *T-38 Honeycomb Structures* above.	
182.	Speed Brakes	Verify proper condition, deflection, and warning signage of the speed brake located under the fuselage. Recommend the USAF speed modifications be considered. The AIP and standard operating procedures (SOP) should address the dangers the air brake poses to ground personnel.	
183.	Yaw Damper	Verify the yaw damper is addressed in the AIP. Note: TO 1T-38-1 discusses the yaw damper: "The Yaw Stability Augmentor System (YSAS) uses utility hydraulic pressure to position the rudder to reduce yaw oscillations. A yaw damper switch, placarded DAMPER is located on the left console of the front cockpit. The switch is spring-loaded to OFF and is held in the YAW position by AC power. The yaw damper is disengaged by returning the switch to OFF. The augmentor disengages automatically in the event of AC power failures. Generator crossover checks can cause YSAS disengagement. The aircraft can be flown safely throughout the flight envelope without the YSAS engaged. Ground operation of the YSAS can result in chatter of the rudder and rudder pedals 5 to 10 seconds after nose wheel activation following turns during ground taxi operations. Following turn completion, the rudder and rudder pedals can chatter for 1 to 2 seconds."	

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184.	Accurate Weight & Balance (W&B)	Review original W&B paperwork. Verify adherence to USAF guidance (TO 1T-38A-5, Basic Weight Checklist and Loading, including forms), as well as FAA-H-8083-1, Aircraft Weight and Balance Handbook, if documentation by the applicant appears to be inadequate. Several former military aircraft accidents have been linked to center of gravity miscalculations. Note: In the T-38, removal of military equipment may have an impact on the aircraft's W&B, especially in those cases where the equipment in question may not be properly documented in the W&B data.	
185.	"Experimental" Markings	Verify the word "EXPERIMENTAL" is located immediately next to the canopy railing, on both sides, as required by § 45.23(b). Subdued markings are not acceptable.	
186.	N-Number	Verify the marking required by §§ 45.25 and 45.29(b) concerning the registration number (N-number), its location, and its size are complied with. If non-standard markings are proposed, verify compliance with Exemption 5019, as amended, under regulatory Docket No. 25731.	
187.	Type of Ejection Seat System	Identify the type of ejection seat fitted to the aircraft. The type of seat changes many aspects of operations and maintenance. Northrop designed and built its own system with upgrades over the years. Each system has specific maintenance and repair requirements. The USAF recently modified T-38 ejection systems to the Martin-Baker US16T seat, which is designed to work with the existing canopy jettison system and provides for dual ejection operation. Applicants may have upgraded to this system as it is commercially available. Refer to *Northrop Grumman Ejection Seat Support* below.	
188.	Northrop Grumman Ejection Seat Support	Ask the applicant whether the ejection seat OEM, Northrop, still supports the T-38 ejection seats, and whether it control part supplies. It is critical to clearly understand if and how the OEM supports both the earlier or upgraded ejections seat. Note: The USAF supply chain is not available to civilian use. Refer to *Type of Ejection Seat System* above.	
189.	T-38 Ejection Seat Overview	The following illustrates some of the intricacies and complexities of the T-38 ejection seat: "The ejection system consists of an ejection seat with drogue chute and man-seat separator, an automatic opening safety belt with 0.65-second delay initiator, an automatic opening parachute with 0.25-second delay initiator or zero delay lanyard parachute with a 1-second delay initiator, and an optional survival kit with an automatic 4 second delay initiator or manual deployment capability. After ejection from the aircraft, the drogue chute deploys to stabilize the seat, the safety belt opens and actuates the man-seat separator forcing the crewmember from the seat. An aneroid delays parachute opening until between 15,000 and 11,500 feet pressure altitude when free falling. At or below this block altitude, parachute opening is initiated at 0.25 second (or 1 second) after seat separation. Low altitude capability (below 2000 feet Above Ground Level (AGL) is provided by the 0.25-second delay initiator. During parachute deployment, the parachute shroud lines pull the optional survival kit auto/release cable and release the kit with a 4 second delay in AUTO mode. MANUAL mode requires the pilot to pull the canopy release handle for deployment. Each cockpit is equipped with a rocket catapult ejection seat. A calf-guard, hinge mounted to the forward end of each seat, is pulled downward behind the crewmember's legs during ejection to prevent the crewmember's legs from being thrust backward beneath the seat by wind blast and to assist in man-seat separation. The handgrips initiate the ejection sequence. The single motion of raising either or both handgrips fires the powered inertia reel and initiates the ejection sequence. During the first part of seat ejection, initial seat movement simultaneously disconnects the oxygen, anti-g suit, and communication disconnects, pulls the calf-guard down, fires the safety belt delay initiator, disconnects the seat adjuster power cable, and initiates drogue gun operation. Each seat is equipped with a canopy piercer and ejects through the canopy if canopy jettison malfunction is experienced. The front seat canopy piercer is attached to the seat and is raised and lowered with the seat. The rear seat canopy piercer is not attached to the seat and remains in a fixed position when the seat is raised and lowered. Two leg-braces, terminating in handgrips, are attached to the ejection seat (one on each side) and are linked together mechanically so that they rise simultaneously. Initial movement of either handgrip releases the down-lock on both leg-braces. When actuated, the leg-braces are held in the raised position by an up-lock and cannot be returned to the down stowed position by the crewmember. The safety pin, when inserted, holds the right leg brace handgrip down, preventing inadvertent seat ejection. The streamer for the ejection seat safety pin is attached to the streamer for the canopy jettison T-handle safety pin. The handgrips are stowed in the down position when the leg-braces are down. When the handgrips are raised fully up and locked, the powered inertia reel retracts and locks and the canopy is jettisoned followed in 0.3 second by seat ejection. The HBU-12/B safety belt is equipped with a 0.65 second delay which provides automatic belt opening during ejection thereby reducing seat separation and parachute deployment time. This reduces the altitude required for safe ejection. The HBU-12/B safety belt has a push-pull release mechanism that can be actuated by the fingers or palm of either hand. A man-seat separation system forcibly separates the crewmember from the ejection seat when the safety belt initiator fires after ejection. On ejection, man-seat separation is aided by full deployment of the drogue chute." For additional information, refer to T.O. 1T-38A-1.	

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190.	Ejection Seat System Maintenance	Ensure maintenance and inspection of the ejection seat and other survival equipment is performed in accordance with the USAF-applicable T.O.s by trained personnel. Include specific inspections and recordkeeping for pyrotechnic devices. Ejection seat system replacement times must be adhered to. No "on condition" maintenance may be permitted for rocket motors and propellants. Make the distinction between replacement times, that is, "shelf life" vs. "installed life limit." For example, a 9-year replacement requirement is not analogous to a 2-year installed limit. If such maintenance documentations and requirements are not available, the seat must be deactivated.	
191.	Ejection Seat Components Life Limit	Ensure life-limit requirements concerning the Weber ejection seat are followed. The guiding documents include TO 11P1-31-7, Specialized Storage and Maintenance Procedures - Rocket Catapult & Ballistic Catapult; T.O. 11P6-1-7, Specialized Storage and Maintenance Procedures - Cartridge Actuated Thrusters; and TO 11P3-1-7, Specialized Storage and Maintenance Procedures - Cartridge Actuated Initiators. No deviations or extensions should be permitted. If the seat is not properly maintained, including current pyrotechnics, it must be disabled.	
192.	Crew Harnesses and HBU-12/B Safety Belt	Verify the harness used by the crew is the required type for the ejection seat used. Accidents have been fatal because of harness issues. Also, the AIP needs to address the maintenance of these items and the HBU-12/B safety belt. As a result, the maintenance of these items will be closely linked to ejection seat maintenance.	
193.	Ejection Seat System Maintainers Training	Require adequate ejection seat training for maintenance crews. On May 9, 2012, an improperly trained mechanic accidentally jettisoned the canopy of a former military aircraft while performing maintenance and was seriously injured.	
194.	Ejection Seat Modifications	Prohibit ejection seat modifications unless directly made by the manufacturer or permitted under the applicable and current USAF T.O.s.	
195.	Ground Support Equipment Maintena nce	Verify the AIP provides for the proper maintenance of all required USAF-approved ground support equipment for the T-38. Related T.O.s must be available as well.	
196.	NASA T-38N Upgrades	In addition to the mentioned USAF upgrades, recommend the improvements made by NASA to its T-38s also be considered. Over the years, NASA continually upgraded its T-38s aircraft to add longevity to its fixed-wing fleet of aircraft. NASA considered retiring its T-38s in the late 1980s. However, it decided its T-38s needed modernization to be safe and more efficient. The upgrade program to the T-38N configuration began in 2000. Thirty-one of the T-38s were upgraded, while one will remain in its original 1960s configuration as a test bed. One major upgrade is the replacement of the original Northrop ejection seat with a Martin-Baker US16LN seat, which expanded the ejection envelope and incorporated an inter-seat sequence enabling individual pilot ejection or command ejection of both pilots by the pilot-in-command. Another T-38 modification involved widening engine inlets to provide a larger thrust area. The widening of the inlets only dropped the maximum speed from Mach 1.17 to 1.16 and provided additional benefits needed during NASA missions. The change also "made the T-38 more efficient at lower speeds and provided an almost 30% increase in climb performance. In a cooperative agreement with General Electric, the engine manufacturer designed ejectors for the exhaust duct of the two GE engines, which improved fuel efficiency at cruise speed of some 8-10%. This modification also enhanced performance in hot-and-high conditions. In the cockpit, the changes were more pronounced; two Honeywell EFIS 50 displays were used to replace some of the round dials inherent in the original T-38 design. These included primary instruments and a horizontal display. A new flight management system was incorporated into the cockpit, based on a Universal GPS. An airborne heading-attitude reference system (AHARS) was added and a new air data computer was incorporated into the update. Much of the revised AHARS was done by Innovative Solutions and Support of Philadelphia. Even with the update, NASA is embarking on yet a further improvement to the T-38 cockpit. A request for proposals is being issued asking for LCD-type displays, to include all the current upgrades plus engine and system displays. The new configuration also must make room for a traffic alert and collision avoidance system (TCAS). NASA officials expect a contract award in July with flight test to begin in 2005 and first delivery of a modified production T-38 expected in 2006." Refer to North, *NASA's Hot Rod*, 2004.	

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T-38 Operating Limitations and Operational Issues			
197.	AIP and Related Documentation	Require adherence to the AIP and related documentation as part of the operating limitations.	
198.	Understanding of the Operating Limitations	Require the applicant to sign the Acknowledgment of Special Operating Limitations form.	
199.	Wing Life Limit	Operations beyond the life limit of the wing are prohibited. Refer to *Wing Inspections and Life Limit* and *Wing Failure (Cracks) (1997 Study) (Part I)* above.	
200.	T-38 Pilot in Command (PIC) Requirements	Ensure the operating limitations address PIC requirements. Direct transition from a modern corporate jet to the T-38 with minimum training is not a safe practice. Refer to the appropriate plot training and checking requirements in FAA Order 8900.1, volume 5, chapter 9, section 2. In addition to holding the required Experimental Authorization, the PIC should (1) have 20 hours dual training in the T-38 in preparation for pilot authorization flight check, (2) have a structured ground school (similar to at least an USAF Short Course), (3) have 1,000 hours in high-performance fighter/fighter-bomber experience in aircraft, (4) have proficiency and currency of 3 to 5 hours per month and 5 to 6 takeoffs and landings (refer to *T-38 Recent Flight Experience* below), and (5) follow standard USAF proficiency standardization check procedures (refer to *USAF T-38 Checkout Procedures* below). The T-38 is a multi-engine aircraft, and the appropriate rating is required.	
201.	T-38 Recent Flight Experience	Recommend proficiency and currency of 3 to 5 hours per month and 5-6 takeoffs and landings. The typical general experience of "at least three takeoffs and three landings within the preceding 90 days" is not sufficient for the safe operation of the T-38.	
202.	PIC Currency in Number of Aircraft	Recommend the operator limit the number of tactical jets the T-38 PIC stays current on. The USAF restricted the number of aircraft types a pilot could hold currency on to two or three. This should be considered by operators who have several aircraft types in their inventory.	
203.	Flight Manuals	Ensure the PIC operates the aircraft as specified in the most current version of the flight manual (USAF manual, AFM) for the T-38 version being flown.	
204.	USAF T-38 Checkout Procedures	Recommend the establishment of T-38 pilot checkout certification process similar to the USAF's, as part of the Experimental Authorization. This training should include a structured ground school process and documentation covering the operation of the aircraft with an emphasis on emergency procedures. Refer to *T-38 Air Force Instructions (AFI) and T-38 Ground/Flight Training* and *USAF T-38 Phase Training* below.	
205.	Annual Checkout	Recommend the PIC conduct an annual checkout on the aircraft.	
206.	Adequate Annual Program Letter	Verify the applicant's annual program letter contains sufficient detail and is consistent with applicable regulations and policies. (Many applicants/operators submit inadequate and vague program letters or fail to submit them on an annual basis.) Also verify the proposed activities (for example, an air show at a particular airport) are consistent with the applicable operating limitations (for example, avoiding populated areas) and do not pose a safety hazard, such as the runway being too short. There may be a need to review the proposed airports to be used.	

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207.	Additional Program Letter Guidance	Ensure program letters accompanying an application for an experimental airworthiness certificate meet the requirements of § 21.193. The letter must be detailed enough to permit the FAA to prescribe the conditions and limitations necessary to ensure safe operation of the aircraft. The letter must include— 1. The purpose for which the aircraft is to be used (such as R&D, crew training, or exhibition). 2. The purpose of the experiment. The letter must describe the purpose of the experiment and the aircraft configuration or modifications, and outline the program objectives. 3. The estimated number of flights or total flight hours required for the experiment and over what period of time (for example, days, or months). 4. The areas over which the experiment will be conducted. A written description or annotated map is acceptable. Specifically describe the area. Describing the operating area as "the 48 states," is not acceptable. The FAA may establish boundaries of the flight test area, including takeoff, departure, and landing approach routing to minimize hazards to persons, property, and other air traffic. However, it is the responsibility of the operator to ensure safe flight of the aircraft. 5. Unless converted from a type certificated aircraft, three-view drawings or three-view dimensioned photographs of the aircraft. 6. Any pertinent information found necessary by the FAA to safeguard the general public. The letter must also include any exemptions that may apply to the aircraft, such as non-standard markings or using an experimental aircraft for hire. 7. If using the aircraft for multiple purposes or roles, (1) documentation of all operations for each purpose, (2) a description of any configuration changes that will occur between each purpose to include adding or removing external stores and enabling or disabling systems, and (3) a separate section for each purpose. For example, an aircraft could have an experimental airworthiness certificate for the purposes of R&D and exhibition. The same aircraft may also conduct military, State, or public aircraft operations (PAO). In this example, the program letter must describe all three roles with the same level of detail. While the airworthiness certificate is not in effect, nor can the FAA prescribe limitations for PAO, the FAA cannot determine the appropriate certification for the aircraft without knowledge of how the aircraft is used. **SAMPLE— Research and Development / Exhibition - Applicant Program Letter for a Special Airworthiness Certificate** • Registered Owner (as shown on Certificate of Aircraft registration): N*AME: Brand X Support Services, Inc., ADDRESS: 123 Airport Street, Any Town, USA 00010.* • Aircraft Description: Registration Marks: i.e., *N12345,* Aircraft Yr. Mfg.: *1965,* Aircraft Serial No. 452*,* and Aircraft Model Designation: Northrop T-38. <u>R&D</u> • Describe program purpose for which the aircraft is to be used (14 CFR 21.193(d) (1)), i.e., *R&D providing chase for Major Airplane Manufacturer for certification testing of their next business jet. Aircraft Certification Office X is the project office. The assigned project number is ACOXzzz;* • Provide the following information as it pertains to your Program Letter (a) List estimated flight hours required for program, i.e. 75 hours*,* (b) List estimated number of flights required for program, number of flights, i.e. *50,* (d) List estimated duration for programs (14 CFR § 21.193(d)(2)), i.e. *150 days;* • Describe the areas over which the flights are to be conducted, and address of base operation (14 CFR 21.193(d) (3)), i.e., *the flights will take place within 150 nm of airport KAAA, excluding the airspace over City-X. The maximum altitude is FL240. The base of operations is Major Airplane Manufacturer Hangar, 12345 Tower Drive, City, etc.;* • Describe the aircraft configuration (attach three-view drawings or three-view dimensioned photographs of the aircraft (14 CFR 21.193(d) (4) and include a description of how the configuration is different from the other purposes listed). *See attached.* <u>Exhibition</u> • Describe program purpose for which the aircraft is to be used (14 CFR 21.193(d)(1)) such as e*xhibition at the following events over the next 8 months, i.e., AirVenture, August 1, 2013;* • Provide the following information as it pertains to your Program Letter (a) list estimated flight hours required for program, i.e., *13 hours exhibition, including the flights to and from the events. 10 hours for crew training; (*b) list estimated number of flights required for program, and (c) list estimated duration for programs (14 CFR § 21.193(d)(2)), i.e. *8 months;* • Describe the areas over which the flights are to be conducted, and address of base operation (14 CFR 21.193(d)(3)), i.e. *crew training flights will take place within 125 nautical miles of Any Town, USA airport with a maximum altitude of 10,000 feet. The base of operations is the address listed above.* • Describe the aircraft configuration (attach three-view drawings or three-view dimensioned photographs of the aircraft (14 CFR 21.193(d) (4) and include a description of how the configuration is different from the other purposes listed). *See attached;* • Date, Name and Title (Print or Type), and Signature.	

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208.	T-38 Flight Manual Warnings, Cautions, and Notes	Consider requiring review (before flight) of all T-38 flight manual warnings, cautions, and notes. Such a review will greatly enhance safety, especially in those cases where the PIC does not maintain a high level of proficiency in the aircraft. The following definitions apply to warnings, cautions, and notes found throughout this instruction. Warning: Explanatory information about an operating procedure practice, or condition that may result in injury or death if not carefully observed or followed. Caution: Explanatory information about an operating procedure, practice, or condition that may result in damage to equipment if not carefully observed or followed. Note: Explanatory information about an operating procedure, practice, or condition that must be emphasized.	
209.	TO 1T-38-1 Section V, Operating Limitations	The PIC must operate the aircraft as specified in section V of TO 1T-38-1, Operating Limitations, in addition to the FAA-approved operating limitations.	
210.	USAF T-38 Safety Supplements	Verify the applicant/operator has incorporated the applicable T-38 safety supplements into operational guidance as appropriate. The most current version of the AFM usually provides a listing of affected safety supplements and this can be used as a reference. Safety supplements addressed and updated safety issues such as proper starter procedures, low airspeed operations, low altitude ejection, and revised EPR settings. Refer to *USAF TO 0-1-1-5* below.	
211.	USAF TO 0-1-1-5	Verify the applicant/operator has incorporated the applicable and current TO 0-1-1-5 in the operational use of the aircraft. This T.O. provides a listing of all current flight manuals, safety supplements, operational supplements, and checklists. Also, check the flight manual title page, the title block of each safety and operational supplement, and the latest status pages contained in the flight manual or attached to formal safety and operational supplements.	
212.	Foreign Aircraft Particularities and Restrictions	Verify whether the aircraft includes aircraft-specific restrictions if it is of foreign origin. If those restrictions exist, the operator must understand those restrictions before flight, especially any post-restoration flight.	
213.	Maintenance and Line Support	Verify the aircraft is operated with qualified crew chief/plane captains, especially during preflight and post-flight inspections as well as assisting the PIC during startup and shutdown procedures. The T-38 has specific starting procedures requiring external power that must be disconnected after engine start, and access panels that must be secured. The following account by a T-38 pilot illustrates the need for adequate ground support: “The T-38 has no self-start capability; it needs a supply of pressurized air to rotate the engines. This air is supplied by a ‘huffer’ unit or *palouste*, which is connected via a large hose to a manifold on the bottom of the airplane, near the left engine. During start, the ground crewman must manually switch the air to the other engine after the first one is started. We're ready to start, so you give the crew chief the ‘air’ signal by raising your arms over your head, making a fist with your left-hand, and slamming it into your right palm. The air rushes into the right engine, and a rising whine begins as the RPM increases. At 14% RPM (12% minimum) you signal that you're ready to start. You reach down with your left hand and press the right engine start button, then move the right throttle to idle. Light-off and spool-up are quick, and the engine is stable at idle RPM less than eight seconds after ignition. The crew chief moves the air diverter valve to the left engine, and you start it the same way. You check the caution-light panel to make sure the engines and related systems are operating correctly, then the ground crewman disconnects the air hose. Next, you run through a series of flight control checks with the ground crewman. He insures that the control surfaces move the way they are supposed to, the main landing gear doors have closed, the speed brakes close properly, and the horizontal stabilator moves to its proper takeoff setting. This completed, you check the flight instruments, cockpit indicators, and navigation gear. The ground crewman removes the wheel chocks on your signal, and it's time to taxi. Ground Control clears you for action.” Refer to http://www.warbirdalley.com/articles/t38pr.htm. Note: A crew chief (USAF) or plane captain (U.S. Navy) is the person (a noncommissioned officer) in charge of the day-to-day operations, maintenance, and ground handling of an aircraft.	

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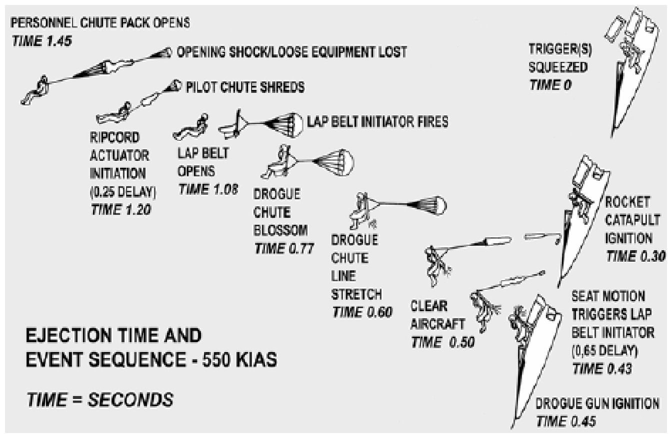
214.	Ejection Seat System PIC Training	Require adequate ejection seat training for the PIC and crew, if applicable, for the type of seat installed. The PIC must also be able to ensure any additional pilot is fully trained on ejection procedures and alternate methods of escape. The T-38, unless modified, does not provide a dual sequenced process for ejection seat activation. The PIC must also ensure the additional pilot does not inadvertently activate the ejection system. Note: Evidence shows the safety record of attempted ejections in civilian former military aircraft is very poor, typically indicating inadequate training leading to ejections outside of the envelope. The ejection envelope is a set of defined physical parameters within which an ejection may be successfully executed. It is primarily an interaction of two independent sets of parameters: the physically designed characteristics of the particular ejection system and the dynamics of the aircraft flight profile at the moment of ejection.  	
215.	Ejection Seat System Ground Safety	Verify the safety of ejection seats on the ground. Verify ejection seats cannot be accidentally fired, including prohibiting untrained personnel from sitting on the seats. As NAVAIR states, "the public shall be denied access to the interior of all aircraft employing ejection seats or other installed pyrotechnic devices that could cause injury." In addition, operators should provide security during the exhibition of the aircraft to prevent inadvertent activation of the ejection system from inside or outside the aircraft by spectators or onlookers. The PIC on a recent former military aircraft operation noted: "Recently we had a case where a guest in the back jettisoned the rear canopy on the ground at the parking position while trying to lock the canopy with the lever on the R/H side… The canopy went straight up for 6 m (20 ft) and fell back on the ground, right in front of the left wing leading edge next to the rear cockpit (fortunately not straight back on the cockpit to punish the guy)." Note: Any ejection seat training must include survival and post-bailout procedures, based either on U.S. Navy or USAF training (or NATO), as appropriate for the equipment being used. Note: As a result of accidents, DOD policy prohibits the public from sitting on armed ejection seats.	
216.	Ejection Seat System Safety Pins	Require the PIC to carry the aircraft's escape system safety pins on all flights and high-speed taxi tests. As a recommendation stemming from a fatal accident, the U.K. CAA may require "operators of civil registered aircraft fitted with live ejection seats to carry the aircraft's escape systems safety pins (a) on all flights and high-speed taxi tests (b) in a position where they are likely to be found and identified without assistance from the aircraft's flight or ground crews."	
217.	Parachutes	The parachute (must an approved parachute for that ejection seat system) must be maintained in accordance with the USAF procedures. Comply with § 91.307, Parachutes and Parachuting. This regulation includes parachute requirements (1) that the parachute be of an approved type and packed by a certificated and appropriately rated parachute rigger, and (2) if of a military type, that the parachute be identified by an NAF, AAF, or AN drawing number, an AAF order number, or any other military designation or specification number. See *Parachute Data* and *USAF T.O. 00-25-241 (Chute Logs and Records)* above.	
218.	Parachutes (Martin-Bakes Mk. 16 Ejection Seat)	As part of the ejection seat system, the parachute (must an approved parachute for that ejection seat system) must be maintained and inspected in accordance with the USAF procedures and standards.	
219.	Engine Operating Limits	Adhere to all engine limitations in the applicable USAF flight manuals.	
220.	Spool Down Time	Verify the AIP incorporates action(s) following a change in the spool down time of the J85-5 engine after shutdown. This is critical as it could be an indicator of an upcoming problem with the engine.	

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221.	External Stores	Prohibit the installation of external stores that were not approved by the USAF. For example, external stores approved for the AT-38 are not to be assumed cleared for installation on a T-38A. No external stores may have an in-flight release mechanism. If travel pods are used, only the two types cleared by the USAF are to be used, and then only on the approved T-38 variant. The same applies to the ALQ-167 ECM pods or other types. Under FAA Order 8130.2, only aircraft certificated for the purpose of R&D may be eligible to operate with functional jettisonable external fuel tanks or stores, but the safety of people and property on the ground still has to be addressed. As the NTSB stated in 2012 following the fatal accident of a high-performance experimental aircraft, “the fine line between observing risk and being impacted by the consequences when something goes wrong was crossed.” In many cases, the pilots may understand the risks they assumed, but the spectators’ presumed safety has not been assessed and addressed.	
222.	External Fuel Tanks	No external fuel tanks are permitted, even in the centerline station if the aircraft is an AT-38B. For example, F-5 external stores, like the 150-gallon fuel tank, are not to be approved for T-38 use.	
223.	Emergency Stores Release Handle (ESRH)	Disable the ESRH, if applicable. Refer to *Master Armament Switch (AT-38)* below.	
224.	Master Armament Switch (AT-38)	Disable and disconnect the master armament switch from any system. Weapon-related buttons (bomb/rocket button, trigger) on the control stick grip and panels must also be disabled and disconnected from all systems.	
225.	Restrict Acrobatics	Restrict acrobatics per the appropriate flight manual.	
226.	Mach Meter and Airspeed Calibration	Require the installation and calibration of a Mach meter or verify the PIC makes the proper Mach determination before flight. Unless the airspeed indicator is properly calibrated, transonic range operations may have to be restricted.	
227.	Accelerometer	Ensure the aircraft’s accelerometer is functional. This instrument is critical to remain within the required G limitation of the aircraft.	
228.	High-Speed Restrictions and Controllability	Recommend limiting transonic operations by 10 percent below MMO. This provides a good safety margin and could be addressed in the operating limitations, the AFM, and related SOPs. MMO is the maximum operating limit speed (V_{MO} / M_{MO} airspeed or Mach Number, whichever is critical at a particular altitude) is a speed that may not be deliberately exceeded in any regime of flight (climb, cruise, or descent). A determination must be made based on the condition of the wing, fuselage, canopies, and tail surfaces on supersonic flight. T-38 operations above 450 KIAS are not recommended. Accident data indicate that operations above this speed contribute to control problems and airframe overstress/failures not otherwise present.	
229.	Phase I Flight Testing	Recommend, at a minimum, all flight tests and flight test protocol(s) follow the intent and scope of acceptable USAF/U.S. Navy functionality test procedures. The aircraft needs detailed Phase I flight testing for a minimum of 10 hours. Returning a high-performance aircraft such as the T-38 to flight status after restoration cannot be accomplished by a few hours of “flying around.” Safe operations also require a demonstrated level of reliability.	
230.	Post-Maintenance Check Flights	Recommend post-maintenance flight checks be incorporated in the maintenance and operation of the aircraft and TO 1-1-300, Maintenance Operational Checks and Flight Checks, dated June 15, 2012, be used as a reference.	

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231.	Flight Over Populated Areas	Prohibit flights over populated areas, including takeoffs and landings. While the experimental category may allow a reduced level of safety for the aircraft when compared to a standard category aircraft, an equivalent level of safety for the public must be maintained. Consider restricting the aircraft to blocks of airspace removed from populated areas, not just over flight of such areas. In all instances, there must be adequate and detailed egress and ingress routes in and out of all airports that are used to avoid flights over and near populated areas. Recommend the general avoidance of populated areas be accomplished by keeping the aircraft a certain distance away from those areas (that is, 2 nautical miles), not just "clear underneath" and not to direct energy at those areas such as keeping the populated areas behind the forward 180° quadrant in relation to the aircraft's flight path. This requires rigorous flight planning. To address this, any airport used must be evaluated as part of the program letter. The PIC must be aware of the areas above which the flight is taking place and coordinate with air traffic control (ATC) accordingly. For example, if an ATC vector will take the aircraft over a populated area, it is not a "clearance" to violate the operating limitation requiring the avoidance of such areas. In this example, the PIC must not accept the clearance and request different routing from ATC. In addition, flight near populated areas needs to address the establishment of any controlled bailout area. Refer to Controlled Bailout Area below. The 1975 accident of a NASA T-38 illustrates the dangers of flights over populated areas: "In 1975 I took off to the west in NASA 924 at El Toro Marine Corps Air Station. The weld that attached the afterburner fuel line to the engine shattered and that fuel flowed to the inside of the aircraft instead of into the engine. It ignited, melted the nozzle off the left engine causing it to compressor stall just as the aircraft lifted off then burned through the firewall between the two engines and set the right engine on fire. In the cockpit the left engine was rolling back, firelights were on for both engines and the tower called that I was on fire and that pieces were falling off the aircraft. I did what I could with the power that remained to gently turn around to the right and land to the north. The fire trucks were on me before I had stopped rolling. The pieces falling from the aircraft started <u>20 to 30 fires</u> in the community adjacent to EL Toro. Astronaut Story Musgrave." Musgrave, *The NASA Northrop T-38,* 2009.	
232.	Controlled Bailout Area	If operational procedures require the establishment of a controlled bailout area, ensure it (1) does not endanger people or property on the ground in any way, (2) follows established USAF procedures, and (3) addresses the possibility of erratic flight paths after ejections. Refer to *Flight Over Populated Areas* above.	
233.	G Limitations	Ensure limits of 4Gs and -1G are imposed. The T-38's history of structural problems dictates this prudent approach. There is no justification to take the aircraft anywhere near its original limitations. The fact that the aircraft could be G loaded does not mean such performance should be attempted or is inherently safe. This is especially true given the aircraft's age and historical use. Maximum G limits should be established below design specifications based on the age and condition of the airframe. Particular attention to the condition of the wings is required because in-flight breakups with the original wings have occurred recently.	
234.	Visual Meteorological Condition (VMC) and Instrument Flight Rules (IFR) Operations	Recommend only day VMC operations. If IFR operations are permitted, prohibit operations in known icing conditions, as the aircraft is not properly equipped for icing conditions. Comply with § 91.205.	
235.	Carrying of Passengers, § 91.319(a)(2)	Prohibit the carrying of passengers (and property) for compensation or hire at all times. For hire flight training is permitted only in accordance with an FAA-issued letter of deviation authority (LODA). FAA LODA policy limits training to pilots eligible for T-38 experimental aircraft authorization.	
236.	Passenger Training and Limitations	Implement adequate training requirements and testing procedures if a person is carried on the back seat [refer to *Carrying of Passengers, § 91.319(a) (2)* above for limitations under § 91.319(a) (2)] to allow the performance of that crew's position responsibilities per the applicable Crew Duties section of the USAF Flight Manual. This training should not be a simple checkout, but rather a structured training program (for example, ground school on aircraft systems, emergency and abnormal procedures, "off-limits" equipment and switches, and actual cockpit training). The back seat qualification should also include (1) ground egress training (FAA-approved ejection seat training), (2) ejection seat and survival equipment training, (3) abnormal/emergency procedures, and (4) normal procedures. In addition to any aircraft-specific (that is, systems and related documentation) training, it is recommended that the *Naval Aviation Survival Training Program* (Non-aircrew NASTP Training) or/and *the United States Air Force Aerospace Physiology Program* (AFI 1 I-403, Aerospace Physiological Training Program) be used in developing these programs. In addition, passenger physiological and high-altitude training should be implemented for all operations above 18,000 ft. This issue can be addressed as part of the operating limitations by requiring the right seat training and incorporating the adequate reference (name) of the operator's training program.	
237.	Spins	Prohibit spins.	

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<tr><th>#</th><th>Issue(s)</th><th>Recommended, Action(s), and Coordination with Applicant</th><th>Notes, Actions, and Disposition</th></tr>
<tr><td>238.</td><td>High-Altitude Training</td><td>Recommend the PIC complete an FAA-approved physiological training course (for example, altitude chamber). Refer to FAA Civil Aerospace Medical Institute (CAMI) Physiology and Survival Training website for additional information.</td><td></td></tr>
<tr><td>239.</td><td>Minimum Equipment for Flight</td><td>Ask the applicant to specify minimum equipment for flight per applicable USAF guidance, and develop such a list consistent with the applicable USAF requirements and § 91.213. Such a list should be based on AFI 21-103 Equipment Inventory, Status, and Utilization Reporting System/T-38A Minimum Essential Subsystem List (MESL). This MESL compliments AFI 21-103, Equipment Inventory, Status, and Utilization Reporting. The MESL is the basis of status reporting IAW AFI 21-103 MESLs and lays the groundwork for reporting the status of aircraft availability. These documents list the minimum essential systems and subsystems that must work on an aircraft for a specified mission.</td><td></td></tr>
<tr><td>240.</td><td>Post-Flight and Last Chance Check Procedures</td><td>Recommend the establishments of post-flight and last chance inspection per USAF guidance. Note: Last chance checks may include coordination with the airport and ATC for activity in the movement areas.</td><td></td></tr>
<tr><td>241.</td><td>Minimum Runway Length</td><td>Recommend a minimum runway length of 8,000 ft. In addition, ensure the PIC verifies, using the appropriate aircraft performance charts (the USAF TO 1T-38B-1-1 Performance Supplement), sufficient runway length is available considering field elevation and atmospheric conditions. To add a margin of safety, use the following:

<u>For Takeoff</u>

• No person may initiate an airplane takeoff unless it is possible to stop the airplane safely on the runway, as shown by the accelerate-stop distance data, and to clear all obstacles by at least 50 ft vertically (as shown by the takeoff path data) or 200 ft horizontally within the airport boundaries and 300 ft horizontally beyond the boundaries, without banking before reaching a height of 50 ft (as shown by the takeoff path data) and after that without banking more than 15 degrees.
• In applying this section, corrections must be made for any runway gradient. To allow for wind effect, takeoff data based on still air may be corrected by taking into account not more than 50 percent of any reported headwind component and not less than 150 percent of any reported tailwind component.

<u>For Landing</u>

• No person may initiate an airplane takeoff unless the airplane weight on arrival, allowing for normal consumption of fuel and oil in flight (in accordance with the landing distance in the AFM for the elevation of the destination airport and the wind conditions expected there at the time of landing), would allow a full stop landing at the intended destination airport within 60 percent of the effective length of each runway described below from a point 50 ft above the intersection of the obstruction clearance plane and the runway. For the purpose of determining the allowable landing weight at the destination airport, the following is assumed:
o The airplane is landed on the most favorable runway and in the most favorable direction, in still air.
o The airplane is landed on the most suitable runway considering the probable wind velocity and direction and the ground handling characteristics of that airplane, and considering other conditions such as landing aids and terrain.</td><td></td></tr>
<tr><td>242.</td><td>Runway Considerations</td><td>Consider accelerate/stop distances, balanced field length, and critical field length in determining acceptable runway use per CJAA guidance. To enhance T-38 operations, it is recommended takeoff procedures similar to the USAF minimum acceleration check speed (using a ground reference during the takeoff run to check for a pre-calculated speed) is adopted. A T-38 pilot explains: “While taxiing out to the runway, you review the Takeoff and Landing Data (TOLD), which you wrote on your knee-mounted data card before leaving the squadron's Operations building. Specifically, you look at four numbers and commit them to memory: The Minimum Acceleration Check Speed (the speed at which you should be traveling a certain distance down the runway, usually 2,000 feet. This number validates all the other numbers, and ensures you have a normally-performing airplane); the Go/No-Go Speed (where you decide to continue the takeoff or abort); the Refusal Speed (the highest speed you can attain and still theoretically stop in the remaining runway length); and the Single-Engine Takeoff Speed (the minimum speed you need in order to take off after an engine failure.) Such cautiousness is required by the military's many years of operational experience with the Talon, and from the experiences of many pilots no longer with us -- whose ignorance of these numbers lead to their demise.” Refer to http://www.warbirdalley.com/articles/t38pr.htm. Also refer to Rejected Takeoff below.</td><td></td></tr>
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243.	Barrier MA-1, MA-1A, and BAK-15	Recommend the use of a barrier (MA-1A) system be considered where available. If a barrier system is used, ensure procedures be developed for this. Refer to AC 150/5220-9, Aircraft Arresting Systems on Civil Airports, dated December 20, 2006. The military installs and maintains aircraft arresting systems when certain military operations are authorized at civil airports. Aircraft arresting systems serve primarily to save lives by preventing aircraft from overrunning runways in cases where the pilot is unable to stop the aircraft during landing or aborted takeoff operations. They also serve to save aircraft and prevent major damage. Aircraft arresting systems must be installed according to the latest official criteria of the military aircraft operational need. In most cases, the criteria can be found in AF) 32-1043, Managing, Operating, and Maintaining Aircraft Arresting Systems. Procedures for T-38 barrier engagement are specified in the flight manual. The MA-1, MA-1A, and BAK-15 are the only suitable barriers.	
244.	Runway Condition Reading (RCR) and Runway Surface Condition (RSC)	Consider using RCR numbers in all T-38 operations. RCR is a measure of tire-to-runway friction coefficient. RCR is given as a whole number. This value is used to define the braking characteristics for various runway surface conditions. The reported RCR is therefore a factor in determining any performance involving braking, such as critical engine failure speed and refusal speed. Some airfields report runway braking characteristics in accordance with ICAO documents as good, medium, and poor. These can be related to ICAO categories. Similarly, RSC can also be used. RSC is the average depth covering the runway surface measured to 1/10 inch (1 inch is equivalent to an RSC of 10). RSC types include: wet runway, standing water, slush on runway, and loose snow on runway. Refer to FAA Order JO7110.65, February 2012, and applicable military guidance.	
245.	Jet Exhaust Dangers	Establish adequate jet blast safety procedures per TO 1T-38A-1.	
246.	Servicing and Flight Servicing Certificate	Ensure the applicant verifies ground personnel are trained for T-38 operations with an emphasis on the potential for fires during servicing. Prohibit non-trained personnel from servicing the aircraft. Recommend a Flight Servicing Certificate or similar document be used by the ground personnel to attest to the aircraft's condition (that is, critical components such as tires) before each flight to include the status of all servicing (that is, liquid levels, fuel levels, hydraulic fluid, and oxygen). Specific servicing areas in the T-38 include: oxygen tanks and filler, fuel fillers (4), engine oil tank, brake control unit, batteries, external power receptacle, rain removal system, single-point refueling (needs to be disabled), emergency air bottle and filler, and hydraulic reservoir.	
247.	Ground Support Equipment	Verify all required ground equipment is available and in a serviceable condition.	
248.	Aerial Target Towing	Restrict all aerial towing. Notwithstanding the standard language in the FAA Order 8130.2 limitations concerning towing, the T-38 is not to be used for towing targets because such operations pose a danger to property and people on the ground and endanger the aircraft. Note: In Specialized USAF use, the AT-38 is capable of aerial towing, including the Low Observable Instrumented Tow (LOIT) and the Patriot Omni Directional Training Aerial Tow (POTA) systems. However, these test installations and associated uses and procedures are not acceptable for civil use.	
249.	Drag Chute Installation and Use	If a drag chute is installed, verify it is done per the applicable USAF T.O. guidance. Because the T-38 was not equipped with a drag chute, Northrop F-5A and F-5B guidance on installation, maintenance, operational use, and limitations may be considered. Special operating limitations may be considered. If ultimately the drag chute installation is approved and it is addressed in the operating limitations, its use must be covered in SOPs. Refer to *Drag Chute* (General), *Drag Chute and Systems Technical Guidance* and *USAF T.O. 00-25-241 (Chute Logs and Records)* above.	
250.	Hot and Pressure Refueling	Prohibit hot and pressure refueling. There are too many dangers with these types of operations. A single refueling point is located on the lower fuselage. Each engine is fed by a separate and independent fuel system, with the center and aft fuselage tanks for the port engine and the forward fuselage tank and dorsal tank for the starboard engine.	
251.	Personal Flight Equipment	Recommend the operator use the adequate personal flight equipment and attire to verify safe operations. This includes a helmet, oxygen mask, fire retardant (Nomex) flight suit, gloves (that is, Nomex or leather), adequate foot gear (that is, boots), and clothing that does not interfere with cockpit systems and flight controls. Operating with a live ejection seat requires a harness. Therefore, recommend only an approved harness compatible with the ejection seat be used.	

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252.	ARFF Coordination	Coordinate with Aircraft Rescue and Fire Fighting (ARFF) personnel at any airport of landing. A safety briefing should be provided and include: an ejection seat system overview; making the ejection seat safe, including location and use of safety pins; canopy jettison; fuel system, fuel tanks; intake dangers, engine shut-off throttle; fuel; batteries; flooding the engines; fire access panels and hot exhaust ports; and crew extraction-harness, oxygen, communications, and forcible entry. ARFF personnel should be provided with the relevant sections of the aircraft AFM and other appropriate references like Fire Fighting and Aircraft Crash Rescue, Vol. 3, Air University, Maxwell AFB, 1958. There is additional documentation to address the issues associated with the potential crash of an aircraft like the T-38. An additional reference is the NATOPS U.S. NAVY Aircraft Firefighting and Rescue Manual, NAVAIR 00-80R-14, dated October 15, 2003. The FAA maintains a series of ACs that provide guidance for Crash Fire Rescue personnel. Refer to AC 5210-17, Programs for Training of Aircraft Rescue and Firefighting. Note: On November 1, 2012, the NTSB issued Safety Recommendation A-12-64 through -67. The NTSB recommends the FAA require the identification of the presence and type of safety devices (such as ejection seats) that contain explosive components on the aircraft. It further stated that that information should be readily available to first responders and accident investigators by displaying it on the FAA's online aircraft registry and that the FAA should issue and distribute a publicly available safety bulletin to all 14 CFR part 139-certificated airports and to representative organizations of off-airport first responders, such as the International Association of Fire Chiefs and the National Fire Protection Association, to (1) inform first responders of the risks posed by the potential presence of all safety devices that contain explosive components (including ejection seats) on an aircraft during accident investigation and recovery, and (2) offer instructions about how to quickly obtain information from the FAA's online aircraft registry regarding the presence of these safety devices that contain explosive components on an aircraft.	
253.	Coordination With Airport	The applicant must provide objective evidence that the airport manager of the airport where the aircraft is based has been notified regarding both the presence of explosive devices in these systems and the planned operation of an experimental aircraft from that airport.	
254.	ATC Coordination	Coordinate with ATC before any operation that may interfere with normal flow of traffic to ensure the requirement to avoid flight over populated areas is complied with. Note: ATC does not have the authority to waive any of the operating limitations or operating rules.	
255.	Formation Takeoffs and Landings	Prohibit formation takeoffs and landings. There is no civil use, including display, to justify the risks involved.	
256.	Military/Public Aircraft Operations	Require the operator to obtain a declaration of PAO from the contracting entity or risk civil penalty for operating the aircraft outside the limits of the FAA experimental certificate. Some T-38 operators may enter into contracts with the DOD to provide military missions such as air combat maneuvering, target towing, and ECM. Such operations constitute PAO, not civil operations under FAA jurisdiction. Verify the operator understands the differences between PAOs and operations under a civil certificate. For example, the purpose of an airworthiness certificate in the exhibition category is limited to activities listed in § 21.191(d). Note: The following notice, which was issued by AFS-1 in March 2012, needs to be communicated to the applicant: "Any pilot operating a U.S. civil aircraft with an experimental certificate while conducting operations such as air-to-air combat simulations, electronic counter measures, target towing for aerial gunnery, and/or dropping simulated ordinances is operating *contrary* to the limits of the experimental certificate. Any operator offering to use a U.S. civil aircraft with an experimental certificate to conduct operations such as air-to-air combat simulations, electronic counter measures, target towing for aerial gunnery, and/or dropping simulated ordinances pursuant to a contract or other agreement with a foreign government or other foreign entity would not be doing so in accordance with any authority granted by the FAA as the State of Registry or State of the Operator. These activities are not included in the list of experimental certificate approved operations and may be subject to enforcement action by FAA. For those experimental aircraft operating overseas *within* the limitations of their certificate, FAA Order 8130.2, section 7, paragraph 4071(b) states that if an experimental airworthiness certificate is issued to an aircraft located in or outside of the United States for time-limited operations in another country, the experimental airworthiness certificate must be accompanied by appropriate operating limitations that have been coordinated with the responsible CAA *before* issuance." For additional information on public aircraft status, refer to 76 FR 16349, Notice of Policy Regarding Civil Aircraft Operators Providing Contract Support to Government Entities (Public Aircraft Operations), dated March 23, 2011.	
257.	TO 00-80G-1 and Display Safety	Recommend using TO 00-80G-1, Make Safe Procedures for Public Static Display, dated November 30, 2002, in preparing for display of the aircraft. This document addresses public safety around aircraft in the air show/display environment. It covers hydraulics, egress systems, fuel, arresting hooks, electrical, emergency power, pneumatic, air or ground launched missiles, weapons release (including inert rounds), access panels, antennas, and other equipment that can create a hazard peculiar to certain aircraft.	

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T-38 Risk Management, SOPs, Training, and Best Practices			
258.	Use of Operational Risk Management (ORM)	Recommend an ORM-like approach be implemented by the T-38 owner/operator. ORM employs a five-step process: (1) Identify hazards, (2) Assess hazards, (3) Make risk decisions, (4) Implement controls, and (5) Supervise. The use of ORM principles will go a long way in enhancing the safe operation of T-38 aircraft. ORM is a systematic decision-making process used to identify and manage hazards. ORM is a tool used to make informed decisions by providing the best baseline of knowledge and experience available. Its purpose is to increase safety by anticipating hazards and reducing the potential for loss. The ORM process is utilized on three levels based upon time and assets available. These include: (1) Time-critical: A quick mental review of the five-step process when time does not allow for any more (that is, in-flight mission/situation changes); (2) Deliberate: Experience and brain storming are used to identify hazards and is best done in groups (that is, aircraft moves, fly on/off); and (3) In-depth: More substantial tools are used to thoroughly study the hazards and their associated risk in complex operations. The ORM process includes the following principles: accept no unnecessary risk, anticipate and manage risk by planning, and make risk decisions at the right level. The following USAF press release is a good ORM-based analysis of a 2011 T-38 accident: "*CULTURE OF RISK TOLERANCE' CITED IN T-38 CRASH PROBE* - 9/1/2011 - RANDOLPH AIR FORCE BASE, Texas -- Investigators found that the Feb. 11 T-38C Talon crash landing at Ellington Field, Texas, resulted from a series of mistakes by a fatigued pilot during landing, and they admonished the pilot's squadron for creating a 'culture of risk tolerance.' The pilot, from the 14th Flying Training Wing at Columbus Air Force Base, Miss., became disoriented and misjudged the landing runway, lost altitude too quickly and allowed his airspeed to fall below a safe level, according to the Air Education and Training Command accident investigation report. This resulted in catastrophic damage to the T-38's landing gear and right wing. The mishap occurred during the fourth sortie of the day as a night solo continuations-training mission into Ellington Field, near Houston, on a squadron cross-country sortie. The pilot safely departed the aircraft when it came to rest on the ground, and he sustained only minor injuries. In addition to the culture of risk tolerance, the report cited inadequate operational risk management of the cross-country weekend plan. 'Inappropriate supervisory policy, combined with inadequate ORM, led to the mishap pilot flying a high-risk mission profile,' the report said. The board further found that the pilot's fatigue, resulting from the aggressive flight plan approved by his squadron, substantially contributed to the mishap. 'Outside of these cross-country weekends, it was rare for an (instructor pilot) to fly four sorties in one day. There was a mindset that a day consisting of four continuation training sorties was generally less risky than a day consisting of three student pilot instructional sorties,' the report said. 'The sortie was (the mishap pilot's) fourth sortie of the day and was flown entirely at night... This mishap was caused by the authorization and execution of a mission having an unnecessarily high level of risk relative to the real benefits.' Damage to the T-38 -- landing gear, engines, right wing, and tail section -- was assessed at $2.1 million. The impact also caused minor damage to the runway, but no damage to private property, the report said. According to Col. Creig A. Rice, AETC director of safety, risk mitigations were put in place to address the issues outlined in the accident investigation report." Refer to http://www.torch.aetc.af.mil/news/story.asp?id=123277394.	
259.	System Safety MIL-STD-882B	Recommend the use of MIL-STD-882B, System Safety Program Requirements, in the operation of T-38 aircraft. This guidance is also useful in the maintenance and operation of high-performance former military aircraft. It covers program management, risk identification, audits, and other safety-related practices.	

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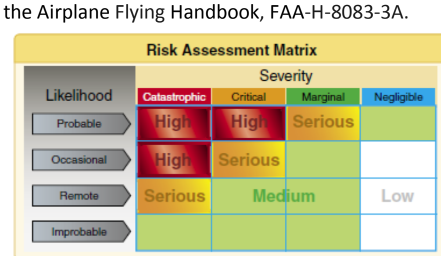
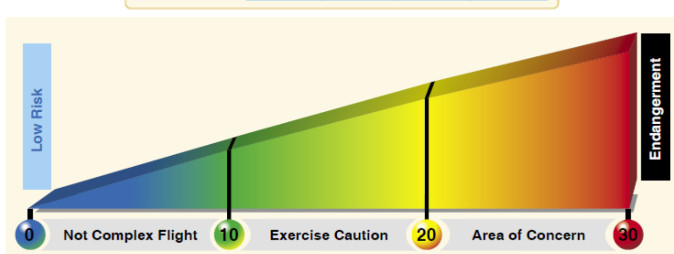
260.	Cockpit Resource Management (CRM) and Single-Pilot Resource Management (SRM)	Recommended the applicant and operator adopt a CRM-type program for T-38 operations. While CRM focuses on pilots operating in crew environments, many of the concepts apply to single-pilot operations. Many CRM principles have been successfully applied to single-pilot aircraft, and led to the development of SRM. SRM is defined as the art and science of managing all the resources (both on board the aircraft and from outside sources) available to a single pilot (prior and during flight) to ensure the successful outcome of the flight. SRM includes the concepts of Risk Management (RM), Task Management I, Automation Management (AM), Controlled Flight Into Terrain (CFIT) Awareness, and Situational Awareness (SA). SRM training helps the pilot maintain situational awareness by managing the automation and associated aircraft control and navigation tasks. This enables the pilot to accurately assess and manage risk and make accurate and timely decisions. Integrated CRM/SRM incorporates the use of specifically defined behavioral skills into aviation operations. Standardized training strategies are to be used in such areas as academics, simulators, and flight training. Practicing CRM/SRM principles will serve to prevent mishaps that result from poor crew coordination. At first glance, crew resource management for the single pilot might seem paradoxical but it is not. While multi-pilot operations have traditionally been the focus of CRM training, many elements are applicable to the single pilot operation. The Aircraft Owners and Pilots Association's (AOPA) Flight Training described single-pilot CRM as "found in the realm of aeronautical decision making, which is simply a systematic approach that pilots use to consistently find the best course(s) of action in response to a given set of circumstances." Wilkerson, Dave. September 2008. From a U.S. Navy standpoint, OPNAVINST 1542.7C, Crew Resource Management Program, dated October 12, 2001, can be used as guidance. Also refer to CRM For the Single Pilot. *Vector* (May/June 2008). FAA guidance includes: Summers, Michele M., Ayers, Frank Ayers, Connolly, Thomas Connolly, and Robertson, Charles. *Managing Risk through Scenario Based Training, Single Pilot Resource Management, and Learner Centered Grading*, 2007, and Chapter 17, *Airplane Flying Handbook* FAA-H-8083-3A. An account of a USAF T-38 accident emphasizes this important issue: "The mission was a local four-ship formation training flight. Shortly after takeoff, the SP flying as Number 2 solo heard a loud noise and felt a loss of thrust as he retarded the throttles out of afterburner. The right engine revolutions per minute (rpm) dropped to approximately 15 percent. The SP attempted an unsuccessful air start while lead repositioned himself to scan his aircraft. Lead reported seeing fire through a hole in the bottom of the aircraft. The aircraft then began un-commanded and uncontrollable pitch oscillations. The IP in the lead aircraft directed the SP to eject. (Although the SP ejected without injury, he inadvertently opened his lap belt either before or during the ejection sequence and was forced to manually deploy his parachute). The aircraft was destroyed upon impact. The right engine turbine wheel failed due to a fatigue crack. The failure resulted in damage to pitch control linkages and loss of aircraft control. Lesson Learned: Emergencies can happen at any time, and the situation can degrade rapidly so *be prepared.* In this case, the SP and IP handled the situation well, using effective cockpit/crew resource management (CRM) and potentially saving the SP's life." Recommend the use of AFI 11-290/AETC Sup 1, Cockpit/Crew Resource Management Training Program.	
261.	Risk Matrix and Risk Assessment Tool	Recommend using a risk matrix in mitigating risk in T-38 operations. A risk matrix can be used for almost any operation by assigning likelihood and severity. In the case presented, the pilot assigned a likelihood of occasional and the severity as catastrophic. As one can see, this falls in the high risk area. The following is a risk assessment tool presented in figure 17-5 of the Airplane Flying Handbook, FAA-H-8083-3A.   Source: FAA	
262.	AFM Addendums	Consider additions or restrictions to the AFM. Operational restrictions should be also addressed in the AFM.	

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263.	T-38 "Road To Wings" (T-38 Safety Report)	Recommend SOPs and training incorporate "Road to Wings," which is a 33-year account of the USAF Air Education Training Command (AETC) aircraft mishaps, with an emphasis on the T-38. This particular handbook covers T-38 aircraft and includes T-38 Class A flight mishap summaries from 1972 through November 2005. The information in this handbook is not intended to establish procedures or be directive in nature. Its sole purpose is to provide pilot training activities a source of lessons learned from history. The majority of mishaps contained within involve undergraduate pilot training missions, and it is from this distinction the handbook derives its title. Refer to http://www.e-publishing.af.mil/shared/media/epubs/AETCH11-210.pdf.	
264.	T-38 Air Force Instructions (AFI) and T-38 Ground/Flight Training	Recommend the applicable USAF AFI, AFM, and AETC manuals for the T-38 be used as an integral part of the operation of the aircraft. Some of the guidance concerning T-38 aircrew training, evaluation criteria, flying fundamentals, and operations procedures includes— • AFI 11-2T-38V1, Series T-38 Aircrew Training; • AFI 11-2T-38V2, Series T-38--Aircrew Evaluation Criteria; • AFI 11-2T-38V3, Series T-38 Operations Procedures; • AFM AN 11-250V1, Series T-38 Flying Fundamentals; • AETC I360-2205v4, Series Formal Flying Training Administration and Management T-38; • Course 01 Intro to UPT Ground Training: UPT T-38 Ground Training; • Course 41 T-38 Academics: Applied Aerodynamics: Basic Aero (Design Features); • Course 41 T-38 Academics: Applied Aerodynamics: Climbing & Gliding Performance; • Course 41 T-38 Academics: Applied Aerodynamics: Endurance & Range; • Course 41 T-38 Academics: Applied Aerodynamics: High Speed Flight; • Course 41 T-38 Academics: Applied Aerodynamics: Stability & Maneuverability; • Course 41 T-38 Academics: Applied Aerodynamics: Takeoff & Landing Factors; • Course 41 T-38 Academics: Applied Aerodynamics: Told Computations: Charts; • Course 41 T-38 Academics: Applied Aerodynamics: Told Computations: Tab Data (Part 1); • Course 41 T-38 Academics: Applied Aerodynamics: Told Definitions; • Course 41 T-38 Academics: T-38 Flight Planning: AFR 60-16 Review (Part 1); • Course 41 T-38 Academics: T-38 Flight Planning: Flip Documents (Part 1); • Course 41 T-38 Academics: T-38 Flight Planning: In-Flight Pubs (Part 1); • Course 41 T-38 Academics: T-38 Flight Planning: In-Flight Pubs (Part 2); • Course 41 T-38 Academics: T-38 Systems: Air Conditioning & Pressurization System; • Course 41 T-38 Academics: T-38 Systems: Aircraft Fuel System; • Course 41 T-38 Academics: T-38 Systems: Communication/Nav (Part 1); • Course 41 T-38 Academics: T-38 Systems: Electrical System (Part 1); • Course 41 T-38 Academics: T-38 Systems: Engines (Part 1); • Course 41 T-38 Academics: T-38 Systems: Flight Control/Hydraulic System (Part 1); • Course 41 T-38 Academics: T-38 Systems: T-38 Systems Overview; and • T-38 Emergency Procedures.	

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265.	T-38 Training Films and Multimedia	Recommend T-38 training incorporate USAF training films and multimedia. These materials, kept up-to-date in addressing many of the aircraft's shortcomings and dangers, are critical for flight safety. These include— • ENERGY MANEUVERABILITY; • HIGH FLIGHT; • T-38 ANGLE OF ATTACK SYSTEM; • T-38 APPROACH TO STALL TRAINING; • T-38 BACK SEAT FORMATION APPROACH/LANDING; • T-38 BACKSEAT OVERHEAD PATTERNS (NORMAL, NO FLAP); • T-38 BACKSEAT REJOINS TO THE NUMBER 2 AND 3 POSITIONS; • T-38 CHECKLIST PROCEDURES; • T-38 CHECKLIST PROCEDURES - PART 2; • T-38 CIRCLING APPROACH; • T-38 CLOSE TRAIL; • T-38 EGRESS; • T-38 EXTENDED TRAIL; • T-38 EXTERIOR INSPECTION; • T-38 FINGERTIP FORMATION; • T-38 FIX TO FIX; • T-38 FLIGHT CHARACTERISTICS/MANEUVERS (PIT); • T-38 FORMATION TAKEOFF AND LANDING; • T-38 INSTRUMENT UNUSUAL ATTITUDE RECOVERIES; • T-38 LANDING PROCEDURES AND TECHNIQUES; • T-38 LOW LEVEL NAVIGATION; • T-38 PITCHOUTS AND REJOINS; • T-38 SINK RATES; • T-38 STRAIGHT IN/SINGLE ENGINE PATTERN; • T-38 TACTICAL FORMATION; and • T-38 TOLD AND ABORT DECISIONS. Refer to http://www.defenseimagery.mil.	
266.	USAF T-38 Phase Training	Recommend SOPs and training incorporate the current USAF Phases of Training for the T-38. These include— • Initial Qualification Training (IQT). This training is necessary to qualify aircrew for duties in the T-38 aircraft. • Mission Qualification Training (MQT). This training is necessary to qualify aircrew for specific unit mission or local area requirements. • Continuation Training (CT). This training is necessary for qualified aircrew to maintain their assigned level of proficiency and/or increase flight qualifications. It provides minimum ground and flight training event requirements. Refer to AFI 11-2T-38 and AFI 11-2T-38, dated January 20, 2011**.**	
267.	In-Flight Canopy Separation	Revise the pilot checklist and back seat occupant briefing to emphasize (that is, "warning—caution") the proper closing of the canopy.	
268.	V_{ne} of 10 Percent Under MMO and Transonic Operations	Recommend limiting transonic operations by 10 percent below MMO. This provides a good safety margin and could be addressed in the operating limitations, the AFM, and related SOPs. MMO is the maximum operating limit speed (V_{MO} / M_{MO} airspeed or Mach Number, whichever is critical at a particular altitude) that may not be deliberately exceeded in any regime of flight (climb, cruise, or descent).	
269.	Fuel Mismanagement	Require special emphasis on fuel starvation and fuel management. Operator must be aware that it is important to note the total fuel load and compare to the fuel indicators to determine accuracy.	
270.	Speed Limitations Due To Avionics and Other Equipment	Verify the speed limit of the aircraft is adjusted to address installed avionics, which may have speed limitations.	

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271.	Brake and Steering System	Recommend an adequate check-out on the aircraft's brake and steering system has been given to anyone taking control of the aircraft on the ground. Poor steering control and/or use of the nose wheel steering have resulted in runway excursions and fatalities. The limitations of the nose-wheel system (that is, 65 knots) must be adhered to.	
272.	Command Ejection	Ensure SOPs address the command ejection issue, that is, who ejects first, per USAF guidance, before the flight if the back seat is occupied. This is a significant issue and a significant difference between T-38s equipped with the older Northrop ejection seat and the new Martin-Baker Mk. 16 seat. Note: This is very important not only because the ejection sequence needs to be understood beforehand, but also because the T-38 has a history of failed ejections (often fatal) due to in-flight collision of the two seats after ejection. The PIC must also be able to ensure any additional occupant is fully trained on ejection procedures and alternate methods of escape. The T-38, unless modified, does not provide a dual sequenced process for ejection seat activation. The PIC must also ensure the additional pilot does not inadvertently activate the ejection system.	
273.	Use of Aft Cockpit Controls, Features, and Switches	SOPs and training should provide for procedures to ensure that all controls, features, and switches in the aft cockpit are not inadvertently operated or in any way interfere with the PIC in the front seat. A good example is the operation of the speed brakes. The T-38 speed brake is a "DC electrically controlled, hydraulically activated dual surface speed brake is located on the lower surface of the fuselage center section. Design of the activation system permits selection of intermediate speed brake positions other than fully extended. A three-position DC powered AFT (EXTEND) - CENTER (HOLD) - FORWARD (RETRACT) speed brake switch is installed on the right throttle in each cockpit The switch in the FCP (front cockpit panel) has positive detents in each position. The switch in the RCP (rear cockpit panel) can override the position selected in the FCP and is spring-loaded to the center HOLD position. Following override, control of the speed brake system is regained in the FCP by moving the switch to HOLD. Intermediate speed brake positions can be obtained by positioning the switch to the desired direction of movement and then returning to the HOLD position. Speed brake creep occurs with the switch in the HOLD position. To prevent creep following actuation from the RCP, the FCP switch should be placed in the position selected in the RCP.	
274.	Weight Limits for the Ejection Seats	If the ejection seat is active, procedures should ensure that for every flight, the weight of any occupant meets design requirements. Note: There is a weight limit for the seat. The following are excerpts from the Air Force's November 1999 Flying Safety article "T-38 Ejection Seat Performance." It provides great insight into the operation of the T-38 ejection seat: *"*Extreme-size crewmembers are those outside the original design limits of the T-38 seat, which in the 1950s, according to the Anthropometry of Flying Personnel, was 132 to 201 pounds. The T-38 seat was upgraded in the 1970s to increase its performance and reliability. It was later re-qualified for crewmembers who weigh from 140 to 211 pounds, the newer size limits. AFI 48-123, *Medical Examination, and Standards*, which governs allowable crewmember size, was recently changed so people who weigh from 103 to 245 pounds may be allowed to operate ejection seat equipped aircraft. This new 'range' is considerably different from the 140-211 pounds that had been the guideline previously. 140-211 pounds equated to 5th-95th percentile males; 103-245 pounds equates to 5th percentile females (5 percent of women are smaller), and 245 pounds represents 98th percentile males (98 percent of men are smaller). For ejection safety, size and weight do matter. Some Congressional members have lobbied to expand the anthropometric range of crewmembers flying fighter and bomber aircraft to those who weigh as little 103 pounds. A lightweight occupant provides many challenges to ejection seat designers, especially coupled with the probability this same seat must be capable of ejecting a 245-pound person also. These 'challenges' are even greater when the T-38 is the aircraft. This is due to the mechanical operation of the seat and the age of the seat subsystems. All prospective fighter and bomber crewmembers must transition through the T-38 en route to their destination aircraft. This 1950s-era ejection seat is one of the slowest, least forgiving seats in operation today; however, used within its design limits, it still provides a safe means to eject. The dilemma is: Do we maintain the seat's current performance, and therefore limit crew size, or do we pursue seat replacement or upgrade? The answer depends on how the USAF plans to work with the expanded crewmember anthropometric range. Approximately 80 percent of female crewmembers weigh between 115 and 135 pounds, and 4 percent of male crewmembers weigh greater than 211 pounds. Granting waivers and allowing people outside the design limit for weight and overall size places them at a higher and unnecessary risk. This is especially true when approaching the extreme ends, which is generally considered less than 115 pounds or greater than 230 pounds. The current T-38 seat was designed, built, tested, and placed in service by the Northrop Corporation, designers, and builders of the T-38 and F-5 aircraft. The T-38 has been—and will continue to be—the mainstay of the USAF pilot training program. It has been a great and capable aircraft. And, due in large part to the visionary leaders at SA-ALC/LF (Proven Aircraft Directorate) and HQ AETC, the T-38 will continue to be a great trainer due to upgrades in the avionics systems, a propulsion modernization program, and wing replacement programs. Each of these major modification programs will ensure the T-38 is capable and maintainable until its planned departure from the USAF inventory in the year 2025, possibly the year 2040. While the avionics, engines, and wings are being modernized into the 2000 era, the seat remains 1950s vintage. The 1950s seat technology, coupled with a tremendous expansion of crew anthropometric ranges, spells danger for ejecting crewmembers." Refer to http://www.afsc.af.mil/shared/media/document/AFD-071016-018.pdf.	

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275.	Single-Engine Handling	Ensure SOPs emphasize single-engine emergencies and handling, including configuration changes. Several T-38 accidents have been related to single-engine practice, namely single-engine approaches. The aircraft is not over-powered and thus this practice needs to include detailed procedures and safety parameters to avoid high-sink rates and undershoots, common in T-38 operations. An USAF T-38 accident account illustrates this: "The flight was an RCP contact mission for the IP who had recently returned from IP training with a flight examiner (FE) in the FCP. After some area work, the aircraft returned to the pattern to practice some landings. The fourth pattern was a full-flap touch and go with the IP flying the aircraft. Everything was normal until just after liftoff. As the gear and flaps were retracting, the left engine rpm rolled back to 60 to 70 percent. The FE assumed control of the aircraft and selected afterburner on the right engine. He then selected afterburner on the left engine, too, but was unable to sustain level flight and ordered ejection. The FE ejected successfully, but the IP was fatally injured due to late chute deployment. Material Factor: Shortly after takeoff the left engine rpm rolled back to 60 to 70 percent due to an undetermined malfunction. The IP did not initially recognize the rollback and initiated gear and flap retraction. The FE recognized engine rollback while assuming aircraft control, but did not notice the gear and flap retraction. He failed to take immediate action to establish the correct aircraft attitude and/or flap position. The FE recognized engine rollback while assuming aircraft control, but did not notice the gear and flap retraction. He failed to take immediate action to establish the correct aircraft attitude and/or flap position." Also refer to *LOC on Landing and Stall on Touch-and-Go* below.	
276.	LOC on Landing and Stall on Touch-and-Go	Ensure SOPs and training focus on the proper techniques for landing. Landing accidents, and especially LOC, are common. The following description of a February 1972 accident illustrates this: "I was a T-38 IP at Reese AFB 1972-75, and a student '71-'72. On 7 March 1972, I was senior student spotter at mobile control when number two, of a two ship formation flight, crashed during a touch and go. Neither the IP nor student ejected (Alexander & Hall). Final approach was normal, but just after touchdown, the aircraft pitched up, then rolled to the left then right (Sabre-dance-like), and ended up inverted on the right side of the runway. Hall died immediately, and Alexander was flown to San Antonio, but died 16 June '72. An Airman's dorm at Reese was named for Alexander. He was an AF Academy grad, class of '68, and rumor was that he hoped to make the Thunderbirds, and had a good chance." Refer to accident report at http://www.texaswreckchasing.com/Military70.htm. Another T-38 accident report drives the point home: "The flight was a pre-solo contact mission. The SP flew a simulated single-engine touch and go prior to departing the traffic pattern. The final approach was steeper than normal with a firm touchdown. Immediately after touchdown, the SP pulled the aircraft back into the air in a nose high attitude and idle power. The aircraft encountered wing rock, and the left wing contacted the runway. The aircraft momentarily leveled off in a near-normal takeoff attitude, but then began to climb with an increasingly nose high attitude. The aircraft rolled left to approximately 60 degrees of bank and then recovered to a near wings level attitude. The aircraft then stalled and impacted the ground in 115 degrees of left bank and 15 degrees nose low. The aircraft was destroyed, and both crewmembers were fatally injured. Stalls during the landing phase leave little to no margin for error. It is critically important to execute proper stall recovery procedures immediately, which may require relaxing the back stick pressure to break the stall condition. Additionally, the loss of aircraft control at a low altitude may not allow time for corrective actions and may require an immediate ejection. Action Taken: Expanded the governing directive to include a discussion of takeoff and landing irregularities such as wing rock, balloon, bounce, premature liftoff, and over rotation."	
277.	High-Altitude Flight and Minimum Mach Number	Recommend the SOPs and training cover high-altitude flight in the T-38. This is because the aircraft, particularly early T-38As with the -5 engine, are not high-performance at high altitudes, and this may present some dangers unless addressed. The following description of operations by the USAF 586th squadron illustrates this: "…however, the Talon (T-38) has some restrictions and therefore do not cover the full spectrum of test requirements. As the engines for the T-38 are not as robust as the engines of an F-16 of F-15, for example, above 35,000 feet, on a standard day or cooler, the aircraft has a minimum Mach restriction. This means that, above that altitude, the pilot has to maintain the minimum Mach speed by moving the throttle only 1 inch every 3 seconds. It gets worse when the temperatures are lower. Then the operational ceiling of the aircraft goes down. This not only restricts aircraft's maneuverability, but moreover does not leave a lot of room for corrections or worse, errors. Consequently, safety requirements sometimes limit the type of profiles that can be flown and some specific high-altitude test requirements cannot be met with the Talon." Refer to Sap, *Desert Testers,* 2005.	

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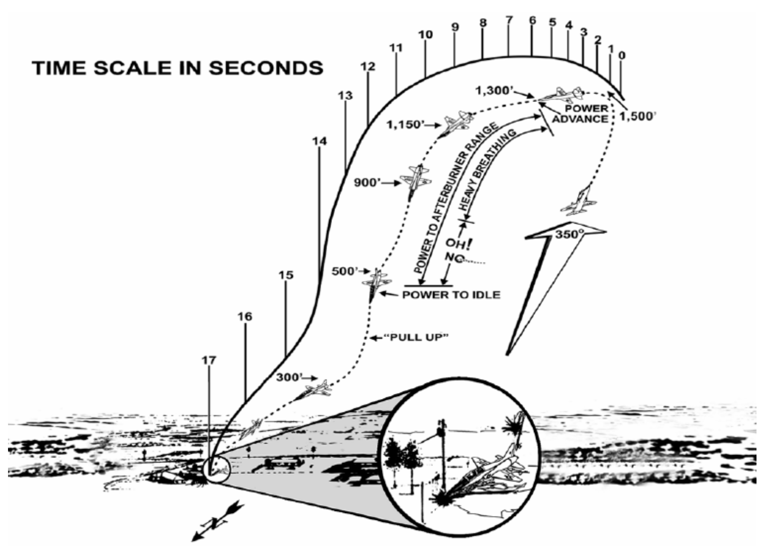
<tr><th>#</th><th>Issue(s)</th><th>Recommended, Action(s), and Coordination with Applicant</th><th>Notes, Actions, and Disposition</th></tr>
<tr><td>278.</td><td>Stall on Turn to Final</td><td>Ensure SOPs and training focus on the proper techniques for avoiding a stall on the turn to finals segment. This is a common T-38 accident cause. The following analysis illustrates this: “The SP completed a normal takeoff and departure for a contact mission. He reported an 8-mile initial approximately 35 minutes later. He pitched out and configured normally, made his gear down call, and began the final turn. He initially rolled to 30 to 35 degrees of bank, but slowly increased the bank to approximately 60 degrees. The aircraft pitched down to an extremely nose low attitude, and the aircraft continued rolling through inverted back to nearly wings level. The aircraft nose came up slightly, but the aircraft continued its rapid rate of descent. The aircraft impacted the ground 30 degrees nose low and with 8 degrees of left bank. The SP was fatally injured, and the aircraft was destroyed. The SP stalled the aircraft in the final turn and was unable to recover. Maintenance investigation determined the aircraft was functioning properly. This is another grim reminder that stalls in the final turn can kill you. If the traffic pattern does not look good, go around and try again. You do not have much altitude or time available to correct a poorly flown traffic pattern. You must detect and correct deviations, such as slow airspeed, excessive bank, and high sink rates, as early as possible. Do not hesitate to execute the stall recovery procedures if it does not look or feel right. In the event of an actual stall, execute the recovery immediately. In this mishap, it is highly possible the SP allowed his airspeed to decrease below final turn airspeed prior to leaving the perch. Instead of increasing airspeed and/or breaking out, he began his final turn and immediately stalled. Action Taken: (1) expanded discussion in the governing directive on flight control effectiveness, particularly the rudder. Cautioned pilots on possible violent aircraft reactions when over-controlling the rudder during stalls and slow-flight maneuvering, and (2) directed minimum airspeed on downwind to be no less than computed final turn airspeed.”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<tr><td>279.</td><td>High AOA</td><td>Ensure SOPs emphasize the risk of high AOA operations and AOA usage in the landing configuration. The USAF stresses in its T-38 training “the importance of AOA in determining the proper aircraft configuration and performance to all T-38 aircrews.” The following accident narrative emphasizes the AOA: “The mishap was a four-ship formation training flight with the mishap SP flying solo. The mission proceeded normally, and the flight returned for landing with the SP as Number 4. The pitchout and pattern spacing appeared normal to witnesses. The SP made his gear down call entering the final turn and indicated he would full stop. Six seconds later he called, ‘on the go.’ The RSU controller noticed the SP was approximately 10 degrees nose low and transmitted, ‘In the final turn, pull your nose up! Burners! Roll your wings level!’ The aircraft continued to roll left, and the nose continued to drop until it impacted the ground. The SP ejected less than 1 second before impact and was fatally injured. The aircraft was destroyed. The number one priority during a final turn stall is to properly execute a stall recovery. Flying the proper pattern ground track is not a consideration unless a greater hazard exists (for example, dual runway operations with another aircraft on final). Ailerons are not as effective as rudder at high angler of attack (AOA), so the use of rudder should be considered as the primary means of rolling wings level. Use caution. It is easy to over control with the rudder because of the high AOA and because you get more rudder travel with the gear down. Action Taken: (1) accelerated AOA indicator installation, and (2) add following warning to T.O. 1T-38A-1: WARNING If a high sink rate is allowed to develop, excessive altitude loss will occur and recovery may not be possible.”</td><td></td></tr>
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280.	Air Start Procedures	Ensure SOPs emphasize the correct emphasizes on air start procedures. This has been the cause of T-38 accidents. The following account illustrates this: "The mishap sortie was a pre-solo contact mission, including a heavyweight single-engine approach, missed approach, and initial acrobatic maneuvers in the area. The IP was flying the aircraft and setting up the next maneuver when the master caution light illuminated. Parameters were 90 degrees of left bank, military power, nose above the horizon, airspeed decreasing through 240 KIAS, and 17,000 feet. The IP noticed both left and right rpm and exhaust gas temperature (EGT) gauges decreasing, pulled both throttles to idle, and pushed both start buttons. He maintained about 150 KIAS during several more normal air start attempts. The IP then cycled both throttles in and out of MAX afterburner and directed the SP to check the boost pump circuit breakers and ensure his throttles were in MAX. The SP then began to cycle his throttles in and out of MAX. The IP told the SP he was going to eject and for him to follow. The aircraft pitched down after the IP ejected. The SP assumed control and attempted several air starts before ejecting himself. During the descent, the T-38 passed beneath the IP close enough for him to hear the engines running. The IP and SP were both uninjured. The aircraft was discovered in a wooded area 4 days later, destroyed upon impact. It appears the right boost pump failed due to an undetermined electrical interruption, flaming out the right engine. The left engine rpm dropped below generator cut-in speed, most likely due to idle decay. The IP failed to take proper emergency actions, to include maintaining aircraft control, analyzing the situation, and referring to the checklist. Apprehension and channelized attention were contributing factors. The IP held the aircraft in a low-speed (150 KIAS), high-sink condition outside the air start envelope, which disrupted his air start attempts. After the crew ejected, the aircraft gained airspeed and both engines restarted. Lesson Learned: Air start procedures are well defined, but the IP made crucial errors when faced with a stressful situation. The only way to combat the effects of stress is to maintain a very high level of proficiency. Supervisors must ensure IPs get enough emergency procedures training to reach the required level of proficiency. Additionally, supervisors must assess each student's ability to cope with stress prior to and after IP/FAR qualification. Because it is hard to define objective criteria regarding 'grace under pressure,' supervisors have to use subjective criteria and their personal judgment when evaluating an SP's ability."	
281.	Hydraulic Failures	Recommend SOPs and training focus on handling of hydraulic failures, especially emphasizing that pilots should not attempt to land the aircraft when a wind-milling engine is providing the only source of hydraulic pressure. The aircraft hydraulic power supply systems include the 3,000 psi utility system powered by the left engine and the 3,000 psi flight control system powered by the right engine. Under normal circumstances there is no interchange between systems. Separate pressure indicators and caution lights are provided for each system. The following accident account not only illustrates a hydraulic failure due to maintenance, but also this important SOP: "The mishap aircraft was on a single-ship functional check flight (FCF). The pilot noted right engine anomalies during the inverted foreign object check. He rolled the aircraft upright and attempted to correct the engine malfunction. The pilot shut down the engine and then noticed an illuminated left hydraulic warning light with corresponding zero pressure. He still had right hydraulic pressure from the wind-milling engine, but it wouldn't be sufficient to land. He made several unsuccessful attempts to restart the right engine and then decided to go to the controlled bailout area to eject. He ejected successfully, but the aircraft was destroyed upon impact. A maintenance specialist incorrectly installed the left hydraulic system reservoir cap. The cap came loose during engine run-up for takeoff. As a result, the left hydraulic system reservoir was unpressurized. Using the speed brakes and landing gear during the FCF profile resulted in momentary cavitations of the left hydraulic pump. These cavitations were also accompanied by momentary illuminations of the master caution and left hydraulic caution lights. The pilot did not consider the momentary illumination of the left hydraulic caution light to be critical, and he continued the mission. The fact it was an FCF and not a training sortie may have contributed to his decision. Flight manual guidance was also inadequate. The left hydraulic reservoir lost enough fluid during the subsequent inverted negative G flight to cause a system failure. The right main fuel control malfunctioned during inverted flight for an undetermined reason, resulting in loss of throttle response. The pilot failed to fully analyze the situation. He shut down the right engine before realizing the left hydraulic system had failed. The main fuel control malfunction prevented a successful air start. The pilot then correctly determined he could not land the aircraft safely. Mishaps are usually the result of a chain of events. If you can break the chain at any of the links, the mishap can be prevented. In this case, the pilot failed to thoroughly analyze the situation. If he had, he might have come up with a different 'game plan,' which would have allowed him to recover the aircraft. Momentary drops in pressure sufficient to cause illumination of the hydraulic caution light may be an indication of an unpressurized system. Land as soon as conditions permit. Avoid zero or negative G flight to prevent fluid loss. The following warning was added to T.O. 1T-38A-1: Do not attempt to land the aircraft when a wind-milling engine is providing the only source of hydraulic pressure."	
282.	Stability Augmenter System (SAS)	Recommend SOPs and training focus on the proper recognition and handling of SAS failure per the applicable USAF procedures.	

#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
283.	Aircraft Pitch Trim Actuator Failure	Recommend SOPs and training focus on the proper recognition and handling of the pitch trim actuator failure. The following account illustrates the consequences of this failure: "The mission was a dual contact sortie and the SP's first ride in the T-38. Takeoff and departure were uneventful. The IP was demonstrating a split-S. As the aircraft approached a nose-low, inverted attitude, he sensed the nose was not tracking or the G-load increasing as expected. The IP made several attempts to regain the proper nose track with no perceptible success. He decided the aircraft could not be controlled and commanded a bailout. Both crewmembers ejected successfully, but the aircraft was destroyed upon impact. For an undetermined reason, the aircraft pitch trim actuator was positioned to the full nose-down position. An electrical short in the control stick trim circuit, a stuck trim button, or an inadvertent pilot input may have induced the full nose-down trim position. The IP was possibly distracted by the lack of aircraft response to control stick inputs and did not recognize the full nose-down trim position. He cycled the control stick rapidly fore and aft several times within a 3-second period in an unsuccessful attempt to regain aircraft control. When aircraft trim is full nose up or nose down, the stick forces required to position the horizontal stabilizer may be several times greater than what the pilot might expect. It will most likely require both hands on the control stick to execute a proper recovery at low altitudes or during a steep nose-low dive. Crewmembers must be alert for unusual flight control and trim inputs, which can be disorienting because of their affect on the aircraft's feel and performance. Action Taken: (1) change the command's study guide, *T-38 Instructor Techniques,* to increase IP awareness of and ability to instruct trim malfunctions and other factors influencing aircraft performance, and (2) incorporated a ground demonstration in the UPT and pilot instruction training (PIT) syllabi to demonstrate the effects of full nose-down trim on stick forces required to achieve a known horizontal stabilizer response."	
284.	Configuration Checks	Recommend SOPs and training focus on configuration checks. The following is an USAF recommendation following a T-38 accident: "Pilots must develop good habit patterns such as checking the configuration more than once before takeoff or landing, to ensure cockpit checks are complete. Checking the aircraft configuration at multiple points may make the difference in an emergency situation. For example, it is important to check the configuration at the perch, in the final turn, and rolling out on final. Pilots might miss something at the perch, but this technique gives them two more opportunities to catch a problem before touching down."	
285.	Revised USAF T-38 Optimal Landing Technique Determination	Recommend the review and consideration of AFFTC-TIM-1O-O1, T-38C Optimal Landing Technique Determination Project Talon Spot, dated May 2010, as part of landing technique training.	
286.	Brake Application	Recommend SOPs and training focus on the proper application of braking action during landing, especially in unusual circumstances. Extreme caution must be exercised when applying wheel brakes above 120 KIAS as locked wheels or tire skids are difficult to recognize. The latest AFM notes that "if tire skid is detected, immediately release both brakes and cautiously reapply."	
287.	Oxygen Check	Recommend SOPs and training require the pilot to perform the "PRICE" check on the oxygen equipment (PRESSURE, REGULATOR, INDICATOR, CONNECTIONS, and EMERGENCY) before every flight if a pressure oxygen system is installed. The acronym PRICE is a checklist memory-jogger that helps pilots and crewmembers inspect oxygen equipment. Mix and match components with caution. When interchanging oxygen systems components, ensure compatibility of the components storage containers, regulators, and masks. This is a particularly important issue because the T-38's age may require the use of modern equipment, at least for some components.	
288.	Spool Down Time	Ensure SOPs incorporate noting the spool down time of the J85-5 engine after shutdown. This is critical, as it could indicate an upcoming problem with the J85 engine.	

#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
289.	End of Runway (EOR) Check	Recommend SOPs and training emphasize the importance of an EOR check, a standard USAF T-38 procedure. The USAF T-38 EOR guidance states: • "Ensure all flight crew checklist items through —Before Takeoff completed. • Check the FCP speed brake switch to ensure it is centered and up. • Review takeoff procedures as well as how you might handle serious emergency procedures during and immediately after takeoff. Review your go/no-go criteria. A common technique is to set the go/no-go speed as the green speed and single-engine takeoff speed (SETOS) as the yellow speed. Another common technique is to set Guard (243.00) in the backup ultra high frequency (UHF) radio as the UHF backup frequency in case of MDP failure during a time critical emergency. • When inspecting the flight control surfaces during the before-takeoff checks, there are two separate tasks. The first task is to visually confirm free and proper movement of the flight control surfaces. Apply smooth and controlled stick movements while confirming the direction and deflection of each flight control surface. Failure to be smooth and controlled could place undue strain on the aileron control mechanisms. The second task is to check for rudder and aileron neutrality. With the stick and rudder pedals in the neutral position, check that all surfaces are approximately flush with the surface of the wing and the vertical stabilizer. It is crucial that this final surfaces check occurs as close as possible to takeoff. The final check of aileron and rudder neutrality should occur no earlier than arriving at the EOR/hold short area and no later than taking the active runway. Check other aircraft for leaks, loose panels, proper configuration, streamers, FOD, etc. If able, make sure their stabilator is properly trimmed for takeoff by inspecting the alignment marks. Alert the aircrew if anything looks abnormal."	
290.	Specific Range	Recommend SOPs address minimum landing fuel. Verify actual aircraft-specific range (nautical air miles traveled per pound of fuel used).	
291.	Bingo and Minimum Landing Fuel	Recommend establishing SOPs addressing minimum landing fuel for IFR operations as provided in § 91.151, Fuel Requirements for Flight in VFR Conditions, in addition to § 91.167, to add a level of safety. In addition, a "Bingo" fuel status (a pre-briefed amount of fuel for an aircraft that would allow a safe return to the base of intended landing) should be used in all flights. Note: Bingo fuel and minimum landing fuel are not necessarily the same, in that a call for Bingo fuel and a return to base still require managing the minimum landing fuel.	
292.	Suspected Flight Control Failure	Recommend establishing SOPs for troubleshooting suspected in-flight control failures, that is, specific checklist procedures, altitude, and clear location. This is very important due to the aircrafts' history of flight control problems.	
293.	Rejected Takeoff	Recommend SOPs and training address the abort decision, including SETOS. Many T-38 accidents have been caused by inappropriate procedures during an abort. A T-38 accident investigation noted: "The mishap aircrew was on an accelerated copilot enrichment (ACE) navigation and cross-country mission. The pilot performed a high speed abort during takeoff at a stopover airfield when the aircraft failed to rotate. The aircraft left the prepared surface and came to a stop 400 feet past the end of the overrun, sustaining major damage. Both crewmembers egressed without injury. Because crewmembers were accustomed to flying at a location where takeoff and landing data were rarely a factor, they became complacent with their takeoff and landing data (TOLD) calculations. Bottom line: The pilot misjudged the takeoff performance based on poor habit patterns and failed to account for a higher temperature and altitude than he was used to. The aircraft did not rotate because the pilot failed to attain proper stick position for rotation. He misjudged aircraft response as a malfunction and aborted the aircraft before it had sufficient time to rotate. Additionally, the pilot initiated his abort 6 knots above refusal speed. (The airspeed markers in both cockpits were set at 155 knots as opposed to the actual refusal or adjusted refusal speed of 149/136 knots). Also, due to improper braking technique, the pilot locked the right brake and blew the tire, causing extensive damage to the wheel assembly. The subsequent directional control problems caused a high speed departure from the prepared surface. Lesson Learned: Complacency can kill you, and this aircrew destroyed a perfectly good aircraft because of it. Take the extra time to do accurate TOLD calculations and make sure you understand what each of the numbers means. Additionally, think about your personal habit patterns." Refer to *Runway Considerations* above.	
294.	FAA AC 91-79	Recommend the use of AC 91-79, Runway Overrun Prevention. According to AC 91-79, safe landings begin long before touchdown. Adhering to SOPs and best practices for stabilized approaches will always be the first line of defense in preventing a runway overrun.	

#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
295.	FAA AC 61-107	Recommend the use of AC 61-107, Operations of Aircraft at Altitudes Above 25,000 ft MSL and/or Mach Numbers (MMO) Greater Than 0.75. This AC can be used to assist pilots who are transitioning from aircraft with less performance capability to complex, high-performance aircraft that are capable of operating at high altitudes and high airspeeds (like the T-38). It also provides knowledge about the special physiological and aerodynamic considerations involved in these kinds of operations.	
296.	360-Degree Overhead Pattern Technique	Recommend the operator consider implementing SOPs to refrain from 360-degree overhead patterns. There is no civil application of this technique. Note: The dangers of an improperly performed 360-degree overhead pattern are illustrated by the following account: "…only weeks before the Alexander and Hall crash, on 24 Feb '72, a solo senior class student pilot 'augered' in (literally) in the final turn to the same runway, 35L. His name was Thomas. A buddy and I were driving to Base for the late shift and saw the smoke, replying to each other 'that's on the wrong side of the road for the firefighters to be practicing.' Sure enough it was Thomas' crash smoke. Accident report at URL:http://www.texaswreckchasing.com/Military70.htm. One needs to understand how formation, overhead traffic patterns work to understand the following explanation. Thomas was solo, number four in a four ship formation flight (near the end of his UPT training - about to get his wings) - but got too close to number three after pitching out in the overhead pattern, apparently tried to get spacing while on inside downwind, got too slow, so when he started his final turn - left wings level flight, he immediately entered a stall. The only way he could possibly have recovered was to roll wings level while going to full afterburner, releasing back pressure, trading altitude for airspeed. Instead, he went to afterburners and kept pulling back pressure, insuring his doom. Don Parks." Refer to www.ejection-history.org.uk/.	
297.	Crosswinds	Recommend the operator consider implementing SOPs that refer to conservative crosswind limitations (possibly more conservative than those in the AFM) and adhere to the appropriate crosswind landing techniques. The following is an analysis of a crosswind T-38 accident: "The mission was an accelerated copilot enrichment (ACE) team sortie. The flight was uneventful until the crew returned to base for an overhead pattern for a full-stop landing. The crosswind component at the time of landing was 12 to 23 knots from the right. The aircraft touched down about 500 feet down the runway in the center. It shortly became airborne again, in left bank. As it departed the left side of the runway, the left wing struck a 3-foot-high snow fence that was 150 feet from the runway edge. The aircraft bank increased to 50 degrees, and the left wing struck the ground. The aircraft rolled back to the right, and all three landing gear impacted the ground. The RCP pilot ejected successfully. The aircraft continued forward on the ground, crashed through another snow fence, crossed a closed runway, and became airborne once more at the edge of a bluff. The FCP pilot ejected as the aircraft became airborne. Although the seat separated from the aircraft, the pilot did not get a full parachute before landing and was fatally injured upon impact. The aircraft continued another 836 feet before impacting an unprepared field 45 feet below the top of the bluff. Both pilots failed to adequately plan for the gusty crosswinds. The RCP pilot indicated they had computed the correct airspeed to include a gust factor, but the airspeed reference markers were both set at the basic approach airspeed. The mishap pilot failed to use prescribed crosswind landing procedures. (Proper procedures are to crab for landing, land on the upwind side, and perform no aerobrake). He landed without a crab in the center of the runway and performed a normal aerobrake, causing the aircraft to drift and become airborne. The pilot over-controlled during the go-around and inadvertently stalled the aircraft. Know and follow TO procedures." T-38 crosswind procedures are discussed in AFMAN 11-251, Flying Operations T-38 FLYING FUNDAMENTALS.	
298.	Outdoors	Recommend establishing SOPs to address the aircraft's sensitivities to weather, including hydraulic seal failures and leakages, freezing moisture, transparencies, air intake, and exhaust protection if necessary.	
299.	Reporting Malfunctions and Defects	Ask the applicant/operator to report incidents, malfunctions, and equipment defects found in maintenance, preflight, flight, and post-flight inspection. This would yield significant safety benefits to operators and the FAA. A 2011 study for the U.S. Navy points to the effectiveness of such practices. It stated: "The data analysis carried out was a comprehensive attempt to examine the strength of the link between safety climate and mishap probability. Our findings would seem to support the premise that safety climate and safety performance are, at best, weakly related. Mishaps are rare events, and they describe only part of the spectrum of risks pertaining to a work system. We suggest that measuring workers' self-reported safety attitudes and behavior is an alternative way to assess the discriminate validity of safety climate." O'Connor, October 2011. In other words, reporting safety issues, such as malfunctions, goes a long way in preventing an accident.	
300.	Cockpit Familiarization	Recommend detailed and comprehensive SOPs/training (not unlike the military-style training known as "blindfold cockpit check with boldface items" conducted in a cockpit or cockpit simulator) be instituted to ensure adequate cockpit familiarization for the PIC.	
301.	Simulated Emergencies	Permit simulated emergencies only in accordance with the T-38 USAF AFM, including emergency and abnormal checklists and in accordance with the limitations issued by the FAA for the aircraft.	

#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
302.	High-G Training	Recommend the PIC and any occupants received training, including techniques to mitigate the potential effects of high-G exposure if operations above 3 Gs are contemplated.	
303.	Transfer of Aircraft Control	Accidents have occurred with two pilots on board when both pilots thought the other was in control. It is recommended that before the flight, the PIC discuss with any other pilot (i.e., back seater) the circumstances under which the PIC would (1) intercede and (2) take control of the aircraft. The transfer of control, could include the following exchange: PIC: "You have the flight controls" - Other pilot: "I have the flight controls" - PIC: "You have the flight controls." During the discussion, it is also recommended to establish whether the PIC wishes the other pilot to conduct any flight crew ancillary tasks. If so, these should be clearly specified to avoid confusion between the PIC and the other pilot. This is particularly important when events are moving quickly and the aircraft is in critical flight segments such as take-off or final approach to landing.	
304.	Medical Fitness for Ejection Seats	Recommend the applicant/operator consider aircrew medical fitness as part of flight qualifications and preparation. In addition to meeting any ejection seat limitations (that is, weight and height) and seat-specific training, relevant U.S. military medical fitness standards could be used to ensure survival after ejection is maximized and injuries minimized. Ejection records show that when survivable, many ejections inflict serious injuries. Examples of aeromedical guidance include AFI 48-123, *Medical Examinations, and Standards*, dated May 22, 2001, and Army Regulation 40-501, *Standards of Medical Fitness*, dated June 14, 1989. Also refer to Defense and Civil Institute of Environmental Medicine, Department of National Defense, Canada. *Ejection Systems and the Human Factors: A Guide for Flight Surgeons and Aeromedical Trainers*, May 1988.	
305.	New USAF T-38 Ejection Seat System	Recommended the new USAF T-38 Ejection Seat System (Martin-Baker MK. 16R, US16) be considered by the operator. With the new the ejection seat, ejection envelope has been significantly increased. Fewer injuries due to lower extremity flail and "wishboning" will be prevented by the active lower extremity restraint system. Chances of seat collision during ejection have been eliminated due to the addition of the sequencing sys-tem. The newer seat expanded the ejection envelope from a low speed of 55 kt. and high of 550 kt. to a zero speed/zero altitude and 600-kt. capability. The new seat also incorporates an inter-seat sequence enabling individual pilot ejection or command ejection of both pilots by the pilot-in-command. The Northrop seat was designed at the time to accommodate a male pilot population. The addition of lower weight and size female pilots and male pilots outside the old limitations also prompted the need for the newer seat. The safety margin provided by the new Martin-Baker ejection seats, and the easier and more reliable support chain for the seats, are other features of the upgrade that rate as very positive. For more information, refer to Escape System Upgrade Program, T-38 Aircraft at http://www.wpafb.af.mil/shared/media/document/AFD-090121-038.pdf.	
306.	49 CFR § 830	Ask the applicant/operator to adopt open and transparent SOPs that promote the use and requirements of 49 CFR § 830, Notification And Reporting Of Aircraft Accidents or Incidents and Preservation of Aircraft Wreckage, Mail, Cargo, and Records, because there have been many instances where accidents and incidents are not reported, hindering safety. Occurrences, which are events other than an accident or incident (that requires investigation by the Flight Standards Service for its potential impact on safety), should also be reported. Occurrences include the following when no injury, damage, or § 830.5 reporting requirements are involved: (1) aborted takeoffs not involving a runway excursion, (2) air turn-backs where the aircraft returns to the departure airport and lands without incident, and (3) air diversions where the aircraft diverts to a different destination for reasons other than weather conditions. Reference should be made of FAA Order 8020.11, Aircraft Accident and Incident Notification, Investigation, and Reporting.	
307.	NATO Aviation Safety Guidance	Recommend the relevant sections of *Aviation Safety* AFSP-1(A), NATO, March 2007, be incorporated into the appropriate operational aspects of the T-38 operations to enhance overall safety. This document, which incorporates many safety issues concerning the safe operation of combat aircraft, sets out aviation safety principles, policies, and procedures—in particular those aimed at accident prevention. This document is a basic reference for everybody involved in aviation safety, both in occurrence prevention (starting from the development, testing, and introduction of material and procedures) and in its aftermath (the determination of the causes of an occurrence and the implementation of measures to prevent its recurrence). It is also recommended this process include internal safety audits. Safety audits help identify hazards and measure compliance with safety rules and standards. They assist in determining the adequate condition of work areas, adherence to safe work practices, and overall compliance with safety-based and risk-reduction procedures.	
308.	BASH (Bird Strike Management)	Recommend that to the extent practicable, operations of the aircraft consider the basics of mitigating the hazards of bird strikes. While all military aircraft are very vulnerable to bird strikes, and the risks are highly dependent on varying issues such as geography and time of year, the operational history of the T-38 includes a high number of bird strikes accidents where the aircraft was actually destroyed (primarily due to engine failure) and in many cases, crew killed. This appears to indicate rather high vulnerability due to the air intake position. USAF guidance, such as *Bird/Wildlife Aircraft Strike Hazard (BASH) Management Techniques*, AFP 91-212, February 1, 2004, can be used.	

#	Issue(s)	Recommended, Action(s), and Coordination with Applicant	Notes, Actions, and Disposition
309.	USAF AFI 91-202	Recommend the incorporation of USAF AFI 91-202, *The Mishap Prevention Program*, August 5, 2011, as part of the operation of the aircraft.	
310.	USAF AFI 11-218	Recommend the incorporation of USAF AFI 11-218, *Aircraft Operations, and Movement on the Ground*, October 28, 2011, Change 1, November 1, 2012, as part of the operation of the aircraft.	
311.	Aircrew Records	Recommend the applicant/operator establish and maintain processes to address aircrew qualifications and records. This could include pilot certification, competency, ground and flight training (records, instructors, conversion training, command training, and proficiency), medical, duty time, and flight time records.	
312.	Type Clubs or Organizations	Recommend the applicant/operator join a Northrop T-38 type club or organization. This facilitates safety information collection and dissemination.	
313.	Emergency Planning and Preparedness	Recommend the applicant/operator institute emergency plans and post-accident management SOPs that ensure the consequences of major incidents and accidents to aircraft are dealt with promptly and effectively.	

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Attachment 4 - Additional Resources and References

Additional Resources

- T-38 Accident data/reports (USAF, NASA, and USN).
- USAF T-38 Aircraft Accident Summary Reports, 1959-Date.
- Air Force Recurring Publication 91-1, *USAF Flying Safety* magazine.
- Northrop Corporation's magazine (*Talon News*).
- USAF Air Force Instructions (AFI) for the T-38.
- Australia's CAAP 30-3(0), *Approved Maintenance Organization (AMO) — Limited Category Aircraft*, Civil Aviation Advisory Publication, December 2001. This publication addresses the restoration and maintenance of ex-military aircraft and is an excellent guide for developing adequate aircraft maintenance and inspection programs.
- CAP 632, *Operation of Permit to Fly Ex-Military Aircraft on the UK Register*. This is a comprehensive source of information and guidance on topics like technical requirements, specialist equipment and systems, pilot/crew qualification, operational requirements, records and oversight procedure, and safety management.
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- *T-38C Optimal Landing Technique Determination Project Talon Spot*, AFFTC-TIM-1O-O1, May 2010.
- U.S. Department of Defense. Manual 4160.28 (volume 3), *Defense Demilitarization: Procedural Guidance,* June 7, 2011.
- USAF AFP 127-1 and NAVAIR 00-80T-116-2*, Technical Manual Safety Investigation, Volume II Investigative Techniques*, July 31, 1987.
- USAF TO 1-1-300, *Maintenance Operational Checks and Flight Checks*, June 15, 2012.
- USAF TO 1-1-691, *Corrosion Prevention, and Control Manual.*

- USAF TO 1-1A-1, *Engineering Handbook Series for Aircraft Repair, General Manual for Structural Repair*, November 15, 2006

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Attachment 5 – Partial Listing of T-38 Accidents and Relevant Incidents

#	Date	Version	Operator	Severity	Probable Cause and Remarks
1.	February 15, 2012	T-38C	USAF	Nonfatal	Tire Burst on Landing (Crosswinds) (AND)
2.	February 11, 2011	T-38C	USAF	Nonfatal	LOC on Landing
3.	May 21, 2009	T-38C	USAF	Unknown	Rudder Failure (Hardover)
4.	May 14, 2009	T-38C	USAF	Nonfatal	Aborted Take-Off – LOC - Runway Excursion (Take-Off)
5.	February 25, 2009	T-38C	USAF	Nonfatal	Aborted Take-Off – Runway Excursion (AND)
6.	February 18, 2009	T-38C	USAF	Nonfatal	Runway Excursion on Landing (AND)
7.	April 23, 2008	T-38C	USAF	Fatal (2)	Aileron Failure on Take-Off
8.	May 1, 2008	T-38C	USAF	Fatal (2)	Undershoot – Go-Around Ejection Seats Collided
9.	November 8, 2007	T-38A	Turkish AF	Fatal (2)	LOC at Night Near the Airfield
10.	February 22, 2007	T-38C	USAF	Nonfatal	Flap Failure
11.	January 18, 2007	T-38C	USAF	Nonfatal	Birds Strike – Engine Failure
12.	December 13, 2005	T-38C	USAF	Nonfatal	Bird Strike
13.	November 16, 2005	T-38A	NASA/N913NA	Nonfatal	Bird Strike
14.	October 14, 2005	T-38A	USAF	Nonfatal	Flight Controls Malfunction on Landing (Ejections)
15.	October 14, 2003	T-38A	USAF	Nonfatal	Mechanical Failure Immediately After Take-Off
16.	March 19, 2003	T-38A	USAF	Fatal (1)	Tire Burst on Landing – Excursion – Inadvertent Ejection
17.	March 8, 2003	T-38A	USAF	Nonfatal	Stall and LOC on Final
18.	August 24, 2001	T-38A	USAF	Fatal (1)	Mid Air (1st Aircraft)
19.	August 24, 2001	T-38A	USAF	Nonfatal	Mid Air (2nd Aircraft)
20.	March 19, 2003	T-38A	USAF	Unknown	Tire Burst on Landing – Excursion – Inadvertent Ejection
21.	December 5, 2000	T-38A	USAF	Nonfatal	Unknown
22.	July 11, 2000	NT-38A	USN	Nonfatal	Possible LOC
23.	December 13, 1999	AT-38A	USAF	Nonfatal	Mid-Air (1st Aircraft)
24.	December 13, 1999	AT-38A	USAF	Nonfatal	Mid-Air (2nd Aircraft) (AND)
25.	June 22, 1988	T-38A	USAF	Fatal (1)	Possible Mid-Air
26.	February 24, 1998	T-38A	RoCAF	Nonfatal	Engine Failure
27.	October 18, 1995	T-38A	USAF	Unknown	Flight Controls Failure
28.	May 31, 1995	T-38A	USAF	Fatal (x)	Crashed into Apartment Complex
29.	October 22, 1987	T-38A	USAF	Unknown	Mid-Air with F-16
30.	September 12, 1993	T-38A	USAF	Unknown	Engine Failure
31.	July 6, 1993	T-38A	USAF	Unknown	Unknown
32.	June 20, 1993	T-38A	USAF	Unknown	Unknown
33.	September 3, 1992	T-38A	USAF	Unknown	Unknown
34.	June 24, 1991	T-38A	USAF	Fatal (2)	Unknown
35.	August 22, 1990	T-38A	USAF	Unknown	Unknown
36.	August 7, 1990	T-38A	USAF	Fatal (4)	Mid-Air with Civilian C-172
37.	August 6, 1990	T-38A	USAF	Unknown	Unknown
38.	May 21, 1990	T-38A	USAF	Unknown	Unknown
39.	June 5, 1989	T-38A	USAF	Fatal (1)	Unknown
40.	May 21, 1989	T-38A	USAF	Nonfatal	Undershoot

41.	May 9, 1989	T-38A	USAF	Unknown	Unknown
42.	May 9, 1989	T-38A	Turkish AF	Unknown	Unknown
43.	April 18, 1989	AT-38A	USAF	Unknown	Unknown
44.	August 8, 1988	T-38A	Turkish AF	Fatal (2)	Unknown
45.	June 22, 1988	T-38A	USAF	Unknown	Unknown
46.	May 22, 1987	T-38A	USAF	Fatal (2)	Mid-Air with Civilian C-206
47.	April 22, 1987	T-38A	USAF	Fatal (2)	Mid-Air (1st Aircraft)
48.	April 22, 1987	T-38A	USAF	Nonfatal	Mid-Air (2nd Aircraft)
49.	January 14, 1987	T-38A	Turkish AF	Fatal (1)	Unknown
50.	July 3, 1986	T-38A	USAF	Unknown	Unknown
51.	April 2, 1986	T-38A	USAF	Fatal (2)	CFIT
52.	February 28, 1986	T-38A	USAF	Nonfatal	Unknown
53.	January 17, 1986	T-38A	USAF	Nonfatal	In-Flight Wing Structural Failure (Ejections)
54.	May 15, 1985	T-38A	USAF	Unknown	Unknown
55.	April 5, 1985	T-38A	USAF	Nonfatal	Bird Strike
56.	January 4, 1985	T-38A	USAF	Fatal (2)	High Sink Rate on Final
57.	October 7, 1984	T-38A	USAF	Fatal (2)	Crashed on Approach
58.	March 21, 1984	T-38A	USAF	Fatal (2)	Mid-Air (1st Aircraft)
59.	March 21, 1984	T-38A	USAF	Fatal (1)	Mid-Air (2nd Aircraft)
60.	July 21, 1983	T-38A	USAF	Unknown	Unknown
61.	May 24, 1983	AT-38B	USAF	Unknown	Unknown
62.	April 5, 1983	T-38A	USAF	Fatal (2)	Unknown (Night Flight)
63.	January 31, 1983	T-38A	USAF	Unknown	Unknown
64.	January 14, 1983	T-38A	USAF	Nonfatal	Crashed into Neighborhood
65.	January 13, 1983	T-38A	USAF	Unknown	Unknown
66.	May 2, 1982	T-38A	USAF	Nonfatal	LOC
67.	March 19, 1982	T-38A	NASA	Nonfat	Lightning Strike
68.	January 18, 1982	T-38A	USAF	Fatal (1)	Flew Into the Ground During Acrobatics (1st Aircraft) (TB)
69.	January 18, 1982	T-38A	USAF	Fatal (1)	Flew Into the Ground During Acrobatics (2nd Aircraft) (TB)
70.	January 18, 1982	T-38A	USAF	Fatal (1)	Flew Into the Ground During Acrobatics (3rd Aircraft) (TB)
71.	January 18, 1982	T-38A	USAF	Fatal (1)	Flew Into the Ground During Acrobatics (4th Aircraft) (TB)
72.	December 10, 1981	T-38A	USAF	Nonfatal	Landing Gear Failure – Ejections
73.	September 8, 1981	T-38A	USAF	Fatal (1)	Bird Strike (One Successful Ejection) (TB)
74.	October 12, 1981	T-38A	USAF	Unknown	Unknown
75.	May 26, 1981	T-38A	USAF	Nonfatal	Bird Strike
76.	May 15, 1981	T-38A	USAF	Unknown	Post-Maintenance Flight (FCF)
77.	May 9, 1981	T-38A	USAF	Fatal (1)	Collision with Ground Vehicle (Too Low) (TB)
78.	March 3, 1981	QT-38A	USAF	Nonfatal	Unknown
79.	January 25, 1981	T-38A	USAF	Nonfatal	Bird Strike – Engine Fire – Crashed into Neighborhood
80.	December 20, 1980	QT-38A	USAF	Nonfatal	Unknown
81.	October 16, 1980	T-38A	USAF	Fatal (1)	Crashed On Approach (One Successful Ejection)
82.	October 8, 1980	T-38A	USAF	Fatal (2)	Unknown
83.	July 28, 1980	T-38A	USAF	Unknown	Unknown
84.	March 29, 1980	T-38A	USAF	Nonfatal	Engine Failure on Take-Off

85.	August 30, 1979	T-38A	USAF	Unknown	Unknown
86.	April 12, 1979	T-38A	USAF	Nonfatal	FCF – Hydraulic Failure (Cap Left Out)
87.	March 19, 1979	T-38A	USAF	Unknown	Unknown
88.	January 29, 1979	T-38A	USAF	Nonfatal	Fuel Starvation
89.	January 15, 1979	T-38A	USAF	Nonfatal	Mid-Air (1st Aircraft)
90.	January 15, 1979	T-38A	USAF	Nonfatal	Mid-Air (2nd Aircraft)
91.	August 31, 1978	T-38A	USAF	Fatal (1)	In-Flight Wing Structural Failure (One Successful Ejection)
92.	August 2, 1978	T-38A	USAF	Unknown	Unknown
93.	July 7, 1978	T-38A	USAF	Fatal (1)	In-Flight Gear Door Separation – LOC (Hydraulic)
94.	July 7, 1978	T-38A	USAF	Fatal (2)	Unknown
95.	June 13, 1978	T-38A	USN	Unknown	Unknown
96.	January 23, 1978	T-38A	USAF	Fatal (1)	Crashed on Final
97.	January 8, 1978	T-38A	USAF	Unknown	Unknown
98.	January 5, 1978	T-38A	USAF	Fatal (1)	Flew Into the Ground – Inadvertent Ejection
99.	August 1, 1977	T-38A	USAF	Unknown	Unknown
100.	July 25, 1977	T-38A	USAF	Fatal (1)	Weather – Crashed While Attempting Landing (TB)
101.	July 21, 1977	T-38A	USAF	Unknown	Unknown
102.	March 30, 1977	T-38A	USAF	Fatal (1)	Possible In-Flight Gear Door Separation (PI)
103.	March 15, 1977	T-38A	USAF	Fatal (2)	Unknown
104.	February 23, 1977	T-38A	USAF	Unknown	Unknown
105.	December 14, 1976	T-38A	USAF	Fatal (1)	Mid-Air (1st Aircraft)
106.	December 14, 1976	T-38A	USAF	Nonfatal	Mid-Air (2nd Aircraft)
107.	November 6, 1976	T-38A	USAF	Unknown	Unknown
108.	October 20, 1976	T-38A	USAF	Fatal (1)	Possible In-Flight Gear Door Separation (Kunsan)
109.	August 24, 1976	T-38A	USAF	Unknown	Unknown
110.	August 17, 1976	T-38A	USAF	Unknown	Undershoot
111.	May 3, 1976	T-38A	USAF	Fatal (1)	Unknown (Successful Ejection) (64th)
112.	February 17, 1976	T-38A	USAF	Fatal (3)	Crashed on Approach – Killed Civilian on the Ground
113.	October 7, 1975	T-38A	USAF	Unknown	Unknown
114.	March 24, 1975	T-38A	RoCAF	Unknown	Mid-Air (1st Aircraft)
115.	March 24, 1975	T-38A	RoCAF	Unknown	Mid-Air (2nd Aircraft)
116.	March 24, 1975	T-38A	RoCAF	Unknown	Mid-Air (3rd Aircraft)
117.	December 18, 1974	T-38A	USAF	Unknown	Unknown
118.	July 22, 1974	T-38A	USAF	Fatal (1)	Single-Engine Approach
119.	May 23, 1974	T-38A	USAF	Unknown	Unknown
120.	May 6, 1974	T-38A	USAF	Nonfatal	Unknown
121.	May 2, 1974	T-38A	GAF	Fatal (2)	C-130 Wake Turbulence
122.	April 25, 1974	T-38A	RoCAF	Unknown	Unknown
123.	February 6, 1974	T-38A	USAF	Nonfatal	Landing Accident
124.	January 19, 1974	T-38A	RoCAF	Unknown	Unknown
125.	January 14, 1974	T-38A	USAF	Fatal (1)	Bird Strike on Take-Off
126.	October 1, 1973	T-38A	GAF	Nonfatal	Unknown
127.	July 13, 1973	T-38A	USAF	Unknown	Unknown
128.	April 30, 1973	T-38A	USAF	Fatal (2)	Unknown

129.	May 19, 1973	T-38A	NASA	Nonfatal	Unknown
130.	May 15, 1973	T-38A	USAF	Unknown	Unknown
131.	April 30, 1973	T-38A	USAF	Fatal (2)	Unknown
132.	January 22, 1973	T-38A	USAF	Unknown	Unknown
133.	January 5, 1973	T-38A	N907NA (NASA)	Unknown	Unknown (AND)
134.	November 28, 1972	T-38A	USAF	Fatal (1)	Unknown
135.	November 27, 1973	T-38A	USAF	Unknown	Unknown
136.	September 9, 1972	T-38A	USAF	Fatal (2)	LOC After Take-Off (Rolled-Over)
137.	July 19, 1972	T-38A	USAF	Unknown	Unknown
138.	July 13, 1972	T-38A	USAF	Unknown	Unknown
139.	May 10, 1972	T-38A	NASA	Nonfatal	Fuel Starvation (C. “P” Conrad)
140.	May 10, 1972	T-38A	USAF	Unknown	Unknown (AND)
141.	March 21, 1972	T-38A	USAF	Unknown	Unknown
142.	March 7, 1972	T-38A	USAF	Fatal (1)	LOC on Landing
143.	February 24, 1972	T-38A	USAF	Fatal (1)	LOC During 360° Pattern (Stall) – Late Ejection
144.	January 20, 1972	T-38A	NASA	Fatal (2)	New Equipment Flight Test
145.	1972	T-38A	USAF	Unknown	Crashed After Take-Off (TB)
146.	July 30, 1971	T-38A	USAF	Unknown	Mid-Air (1st Aircraft)
147.	July 30, 1971	T-38A	USAF	Unknown	Mid-Air (2nd Aircraft)
148.	July 26, 1971	T-38A	USAF	Fatal (1)	Night CFIT
149.	June 27, 1971	T-38A	USAF	Fatal (2)	Crashed Shortly After Take-Off
150.	May 5, 1971	T-38A	USAF	Fatal (1)	Crashed During Night Touch-and Go Practice
151.	February 3, 1971	T-38A	USAF	Unknown	Unknown
152.	1971	T-38A	USAF	Unknown	Unknown
153.	December 16, 1970	T-38A	USAF	Unknown	Unknown
154.	December 14, 1970	T-38A	USAF	Unknown	Unknown
155.	December 11, 1970	T-38A	NASA	Nonfatal	In-Flight Canopy Malfunction
156.	December 3, 1970	T-38A	USAF	Unknown	Unknown
157.	October 1, 1970	T-38A	USAF	Unknown	Unknown
158.	September 8, 1970	T-38A	USAF	Unknown	Mid-Air (1st Aircraft)
159.	September 8, 1970	T-38A	USAF	Unknown	Mid-Air (2nd Aircraft)
160.	September 4, 1970	T-38A	USAF	Unknown	C-141 Wake Turbulence
161.	August 27, 1970	T-38A	USAF	Unknown	Unknown
162.	August 25, 1970	T-38A	USAF	Unknown	Unknown
163.	August 25, 1970	T-38A	USAF	Unknown	Unknown
164.	August 14, 1970	T-38A	USAF	Unknown	Unknown
165.	August 12, 1970	T-38A	USAF	Unknown	Unknown
166.	August 11, 1970	T-38A	USAF	Unknown	Unknown
167.	May 27, 1970	T-38A	USAF	Unknown	Unknown
168.	April 20, 1970	T-38A	USAF	Unknown	Unknown
169.	March 9, 1970	T-38A	USAF	Unknown	Unknown
170.	January 31, 1970	T-38A	USAF	Unknown	Unknown
171.	December 9, 1969	T-38A	USAF	Unknown	Unknown
172.	August 13, 1969	T-38A	USAF	Unknown	Unknown

173.	August 12, 1969	T-38A	USAF	Unknown	Unknown
174.	July 17, 1969	T-38A	USAF	Unknown	Unknown
175.	May 13, 1969	T-38A	USAF	Unknown	Unknown
176.	May 3, 1969	T-38A	USAF	Unknown	Unknown
177.	October 7, 1968	T-38A	USAF	Unknown	Unknown
178.	November 7, 1968	T-38A	USAF	Unknown	Unknown
179.	October 7, 1968	T-38A	USAF	Unknown	Unknown
180.	September 30, 1968	T-38A	USAF	Nonfatal	Unknown
181.	September 11, 1968	T-38A	USAF	Nonfatal	Unknown
182.	August 22, 1968	T-38A	USAF	Unknown	Unknown
183.	April 9, 1968	T-38A	USAF	Unknown	Unknown
184.	March 12, 1968	T-38A	USAF	Unknown	Unknown
185.	March 7, 1968	T-38A	USAF	Unknown	Unknown
186.	January 29, 1968	T-38A	USAF	Unknown	Unknown
187.	November 24, 1967	T-38A	USAF	Unknown	Unknown
188.	October 30, 1967	T-38A	USAF	Unknown	Unknown
189.	October 5, 1967	T-38A	NASA	Fatal (1)	Flight Controls Mechanical Failure (C. Williams)
190.	September 6, 1967	T-38A	USAF	Unknown	Post-Maintenance Flight (FCF)
191.	August 17, 1967	T-38A	USAF	Unknown	Unknown
192.	August 1, 1967	T-38A	GAF	Fatal (1)	Unknown
193.	July 31, 1967	T-38A	USAF	Unknown	Unknown
194.	June 22, 1967	T-38A	USAF	Unknown	Unknown
195.	June 22, 1967	T-38A	USAF	Unknown	Unknown
196.	May 28, 1967	T-38A	USAF	Unknown	Unknown
197.	May 12, 1967	T-38A	USAF	Fatal (1)	Unknown
198.	April 18, 1967	T-38A	USAF	Nonfatal	In-Flight Canopy Disintegration
199.	February 16, 1967	T-38A	USAF	Unknown	Mid-Air (1st Aircraft)
200.	February 16, 1967	T-38A	USAF	Unknown	Mid-Air (2nd Aircraft)
201.	November 18, 1966	T-38A	USAF	Unknown	Unknown
202.	November 7, 1966	T-38A	USAF	Unknown	Unknown
203.	November 4, 1966	T-38A	USAF	Unknown	Bird Strike
204.	June 25, 1966	T-38A	USAF	Unknown	Unknown
205.	June 7, 1966	T-38A	USAF	Unknown	Unknown
206.	May 17, 1966	T-38A	USAF	Unknown	Unknown
207.	May 17, 1966	T-38A	USAF	Unknown	Unknown
208.	February 28, 1966	T-38A	NASA	Fatal (2)	Missed Approach (NASA) (E. See and C. Bassett)
209.	February 19, 1966	T-38A	USAF	Fatal (1)	Unknown
210.	January 12, 1966	T-38A	USAF	Unknown	Mid-Air (1st Aircraft)
211.	January 12, 1966	T-38A	USAF	Unknown	Mid-Air (2nd Aircraft)
212.	1966	T-38A	USAF	Unknown	Unknown
213.	December 15, 1965	T-38A	USAF	Unknown	Unknown
214.	August 26, 1965	T-38A	USAF	Unknown	Mid-Air (1st Aircraft)
215.	August 26, 1965	T-38A	USAF	Unknown	Mid-Air (2nd Aircraft)
216.	August 26, 1965	T-38A	USAF	Unknown	Mid-Air (3rd Aircraft)

217.	June 30, 1965	T-38A	USAF	Unknown	Unknown
218.	June 8, 1965	T-38A	USAF	Unknown	Unknown
219.	May 14, 1965	T-38A	USAF	Nonfatal	Landing Gear Failure (Ejection)
220.	May 7, 1965	T-38A	USAF	Unknown	Unknown
221.	February 10, 1965	T-38A	USAF	Unknown	Unknown
222.	1965	T-38A	USAF	Unknown	Unknown
223.	1965	T-38A	USAF	Unknown	Unknown
224.	October 31, 1964	T-38A	NASA	Fatal (1)	Bird Strike (T. Freeman)
225.	October 10, 1964	T-38A	USAF	Unknown	Mid-Air (1^{st} Aircraft)
226.	October 10, 1964	T-38A	USAF	Unknown	Mid-Air (2^{nd} Aircraft)
227.	June 7, 1964	T-38A	USAF	Fatal (2)	Unknown
228.	June 1, 1964	T-38A	USAF	Unknown	Unknown
229.	February 27, 1964	T-38A	USAF	Unknown	Unknown
230.	February 12, 1964	T-38A	USAF	Unknown	Unknown
231.	1964	T-38A	USAF	Unknown	Unknown
232.	1964	T-38A	USAF	Unknown	Unknown
233.	1964	T-38A	USAF	Unknown	Unknown
234.	November 13, 1963	T-38A	USAF	Unknown	Unknown
235.	August 28, 1963	T-38A	USAF	Unknown	Unknown
236.	August 13, 1963	T-38A	USAF	Unknown	Unknown
237.	February 5, 1963	T-38A	USAF	Unknown	Unknown
238.	July 18, 1962	T-38A	USAF	Unknown	Unknown
239.	July 2, 1962	T-38A	USAF	Nonfatal	Single-Engine Approach
240.	February 19, 1962	T-38A	USAF	Fatal (2)	Unknown

OVERVIEW OF T-38 CLASS A FLIGHT MISHAP SUMMARY (Partial)

(1972 THROUGH NOVEMBER 2005)

1972

- Gear-up Landing
- Runway Departure
- Final Turn Stall
- Crash Landing
- Lost Control
- Formation Midair
- Landing Gear Malfunction FCF Maintenance
- Takeoff Crash
- Engine Failure Take-Off
- Final Turn Crash

1973

- Final Approach Crash
- Instrument Approach
- Final Turn Stall
- Runway Departure and Landing
- Lost Control and Cruise
- Landing Gear Malfunction
- Premature Gear Retraction

1974

- Bird Strike Dual Bird Strike
- Instrument Approach Dual Wake Turbulence
- Bird Strike PIT Bird Strike
- Compressor Stall and Touch and Go
- Compressor Stall and Touch and Go
- Night Instrument Approach
- Runway Departure
- Lost Control—Area

1975

- Departure Crash (Maintenance)

1976

- Circling Approach
- Circling Approach
- Night Disorientation
- Instrument Approach
- Crash Landing
- Formation Midair

1977

- Aileron Disconnect (Maintenance)
- Wing Failure
- Aileron Malfunction (Material)
- Aileron Disconnect
- Lost Control (Material)

1978

- High Speed Abort
- Final Turn Stall
- Circling Approach
- Lost Control
- Wing Failure

1979

- Formation Midair
- Landing Gear
- Dual Engine Flameout
- Left Hydraulic Failure and Right Engine Failure FCF Material and Maintenance
- Lost Control and Cruise

1980

- Final Turn Stall
- Final Turn Stall
- Short Landing

1981

- Engine Failure
- Stabilator Disconnect FCF
- Landing Gear Failure

1982

- Flap Failure (Material)

1983

- Engine Failure
- Final Turn Stall
- Night Disorientation
- Flap and Slap Disconnect

1984

- Formation Midair
- Circling Approach

1985

- Final Turn Crash
- Bird Strike

1986

- Wing Failure
- Lost Control
- Low Level Crash
- Lost Control and Landing

1989

- Final Approach Crash

1990

- Midair Dual

1991

- Stall and Touch and Go

1992

- Bird Strike

1993

- Engine Failure
- Engine Failure and Fire

1995

- Engine Failure and Loss of Flight Controls
- Loss of Control and Flight Control Malfunction

2000

- Loss of Control and Flight Control Malfunction

2001

- Midair Collision

2003

- Runway Departure and Blown Tire
- Poor Transfer of Aircraft Control

Feedback Information

Please submit any written comments or recommendations for improving this document, or suggest new items or subjects to be added to it. Also, if you find an error, please tell us about it.

Subject: Aircraft Job Aid T-38
To: AIR-230
Date:

(*Please check all appropriate line items)*

- An error (procedural or typographical) has been noted in Item # _______ on page _______.

- Recommend text in Item# _______ on page _______ be changed as follows:

(Attach separate sheet if necessary)

- In a future change to this document, please include coverage on the following subject

(Briefly describe what you want added):

- Other comments:

- I would like to discuss the above. Please contact me.

Submitted by: ____ Date: _________________
Telephone Number: ___________________ Routing Symbol: ____________________

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Mr. Russ Cass
DANGER
RESCUE
Spirit of
Knob Noster